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Special Rigging and Equipment for the Foundry

How Molding Economies are Effected by the Adoption of Simple But Practical Devices that Increase Production

IT HAS been said that the success of a foundry can be measured by its special rigging and equipment, and if a shop so provided is not on a profit-making basis, the special devices and labor-saving machinery at least reflect ingenuity on the part of the foreman, superintendent, or whoever may be in charge of the foundry. Whether it is advisable to make special equipment for an occasional job must be decided entirely by the economies that can be effected, but for castings for which repeat orders are constantly received, the cost of production can be reduced greatly by rigging-up especially for the work. The pattern, if necessary, should be altered to facilitate molding by the method that has been

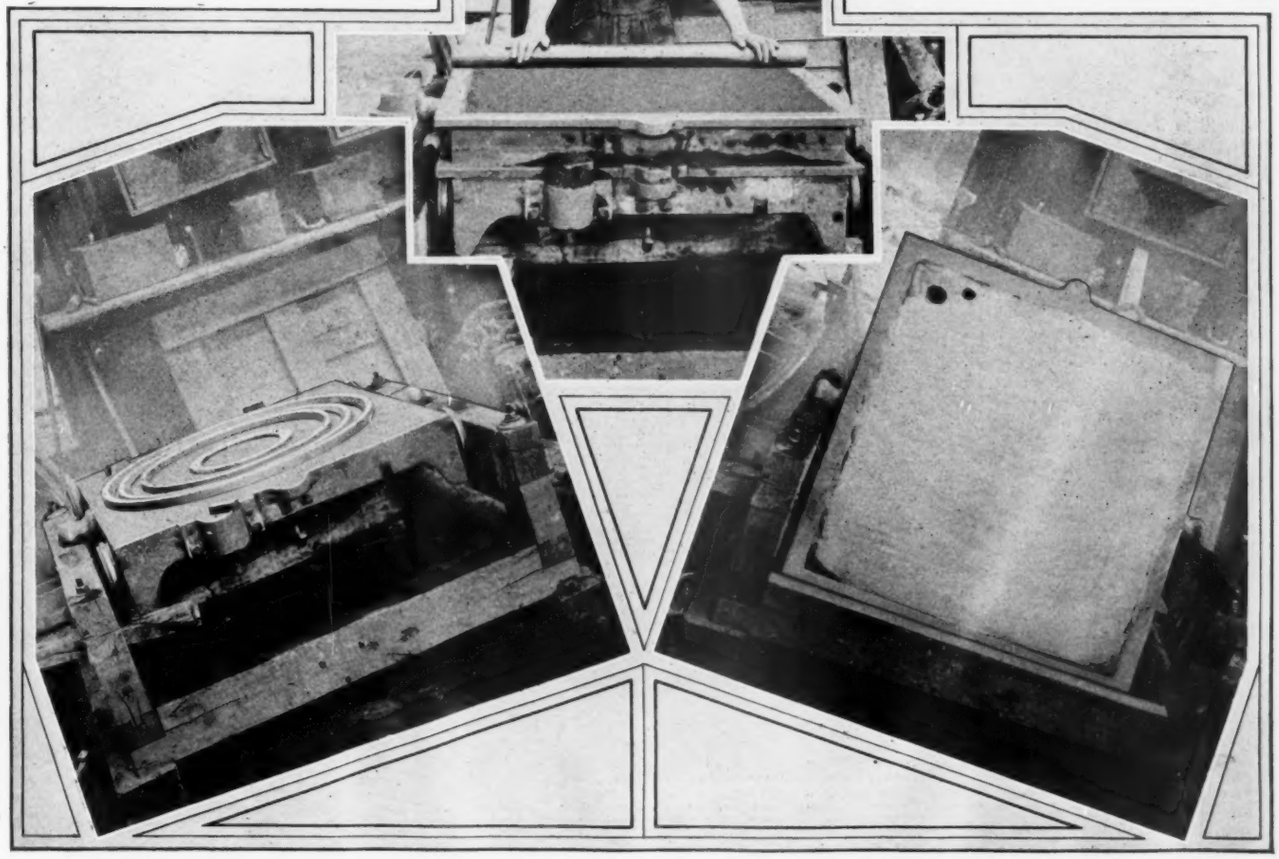


FIG. 1—PATTERN PLATE IN MOLDING POSITION

FIG. 2—ROLLING THE COPE SIDE OF THE MOLD

FIG. 3—ROLLING OVER THE MOLD AND PATTERN PLATE

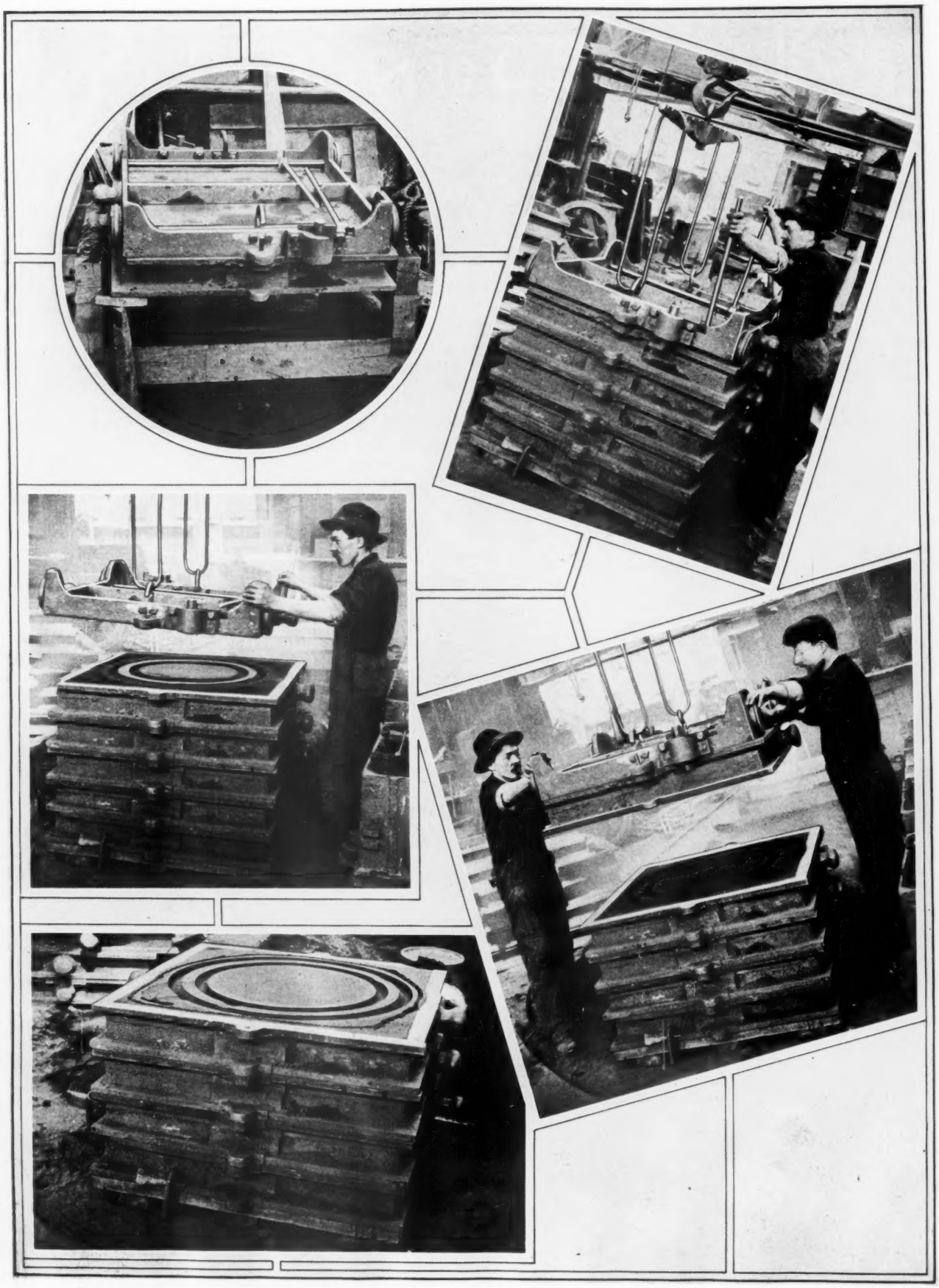


FIG. 4—THE MOLD AND PATTERN PLATE ROLLED OVER
FIG. 6—LIFTING AWAY THE PATTERN PLATE
FIG. 8—DRAG SIDE OF MOLD FOR TWO END RINGS

FIG. 5—DRAWING THE PATTERN BY LIFTING THE PATTERN PLATE AWAY FROM THE MOLD
FIG. 7—LOWERING THE MOLD ONTO THE STACK

agreed upon by the shop executives and the flasks should be made to conform to the size and shape of the casting. The saving in the cost of manufacture will be in proportion to the skill displayed in rigging-up the job, and regardless of the saving in dollars and cents, the special equipment adopted invariably is the forerunner of generally improved shop practice.

In Fig. 1 is shown a pattern plate mounted on a wood frame, especially adapted to molding motor end rings. It can be used, however, for almost any kind of flat work and is exceedingly ingenious in construction. At the Cleveland foundry of the Westinghouse Electric & Mfg. Co., where this device was built and installed, the casting of motor end rings constitutes a part of the regular work of the shop. To economize floor space, it also was decided to stack the molds.

These rings, cast in gray iron, vary in diameter from 18 to 36 inches, are from ⅞ to 1 inch thick and the faces range from ½ to 2¼ inches in width. Before the special pattern plate equipment was adopted, the rings were molded in a two-part flask, the cope having been barred to support the large area of shallow sand. Although a number of rings of different diameters were made in each mold—the number depending largely on the orders received—flasks of a uniform size were used and sufficiently large for the 36-inch rings. A floor of these molds covered a large area and the employment of a two-part flask entailed a greater molding cost than the process now pursued.

The ring patterns are made of cast iron and are drilled to correspond with holes on the machined surface of the cast iron pattern plate. The holes in the pattern plate are drilled accurately for rings of every diameter and the patterns are attached to the plate with screws. The plate, it will be noted in Fig. 1, is supported on trunnions which revolve in curved recesses on top of the side frames. The plate also is provided with a pattern-drawing device which lifts the plate and patterns away from the mold. The plate, in Fig. 1, is in position to receive the flask and is prevented from turning by a bar inserted through the frame at the left. To level the plate an ordinary wedge is employed. In Fig. 2 the mold has been rammed and instead of slicking the surface after striking-off with a straight-edge, the mold is rolled with a section of steel shafting. In this way an absolutely level surface is obtained and the time usually consumed in performing the slicking operation by hand is greatly reduced. In the meantime the flask has been clamped at both ends by a special clamp, clearly shown in Fig. 4. The clamping bar at its lower end has an opening for a steel wedge and the opposite end engages with the flange on the flask. Before rolling over the mold, the surface is coated with plumbago, as shown in Fig. 3, which illustrates the mold as it is being rolled-over on the pattern plate trunnions. In this connection it should be noted that each mold consists of cope and drag and the side clearly shown in Fig. 3 forms the cope of the preceding mold in the stack. Thus, the molding operations have been reduced one-half, as both cope and drag are rammed at the same time.

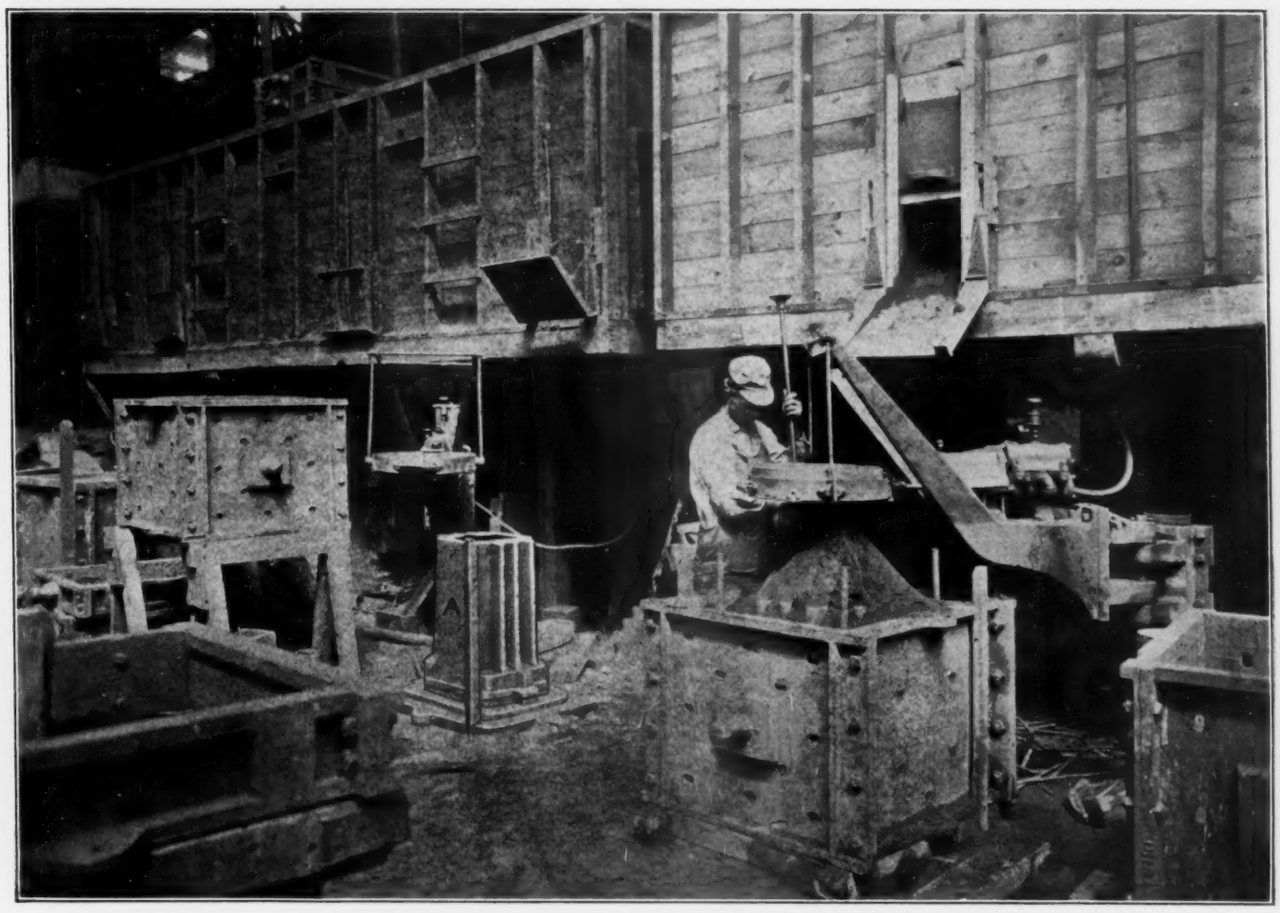


FIG. 9—SPECIAL EQUIPMENT FOR MOLDING TRANSFORMER CASES

In Fig. 4 the mold has been rolled-over and is supported until the arrival of the crane. This view clearly illustrates the bottom of the pattern plate and the two levers which are raised to lift away the pattern plate

and to withdraw the patterns from the mold. The levers are attached to two shafts to the ends of which eccentrics are fastened which are rotated inside of the four wheels when the two pattern-drawing levers are raised. The four wheels contact with the flask side flanges which form bearings for the wheels. When the levers are lifted, the eccentrics are actuated and the pattern plate and patterns are lifted away from the mold. This operation is shown in Fig. 5. The mold and pattern plate are conveyed to the stack by a crane, although the rolling-over operation is performed by the molder. Hooks by the operator and fixed in a stationary position, is ready to receive another flask.

The molds are stacked seven-high and the metal is poured into the sprue direct, no runner being employed. The output, by this method of molding, not only has been increased, but better castings are being obtained and the losses have been greatly reduced. Previously, when a barred cope flask was used, the rings occasionally were swollen opposite the bars and the castings were rejected as they are used without being machined. The single flask now employed, although slightly barred to retain the sand, is sufficiently deep to permit of locating the bars considerably below the flask joints. The roll-over pattern or match-plate to which the patterns are attached is 40 inches square, while the flasks are of the same dimensions and 6 inches deep.

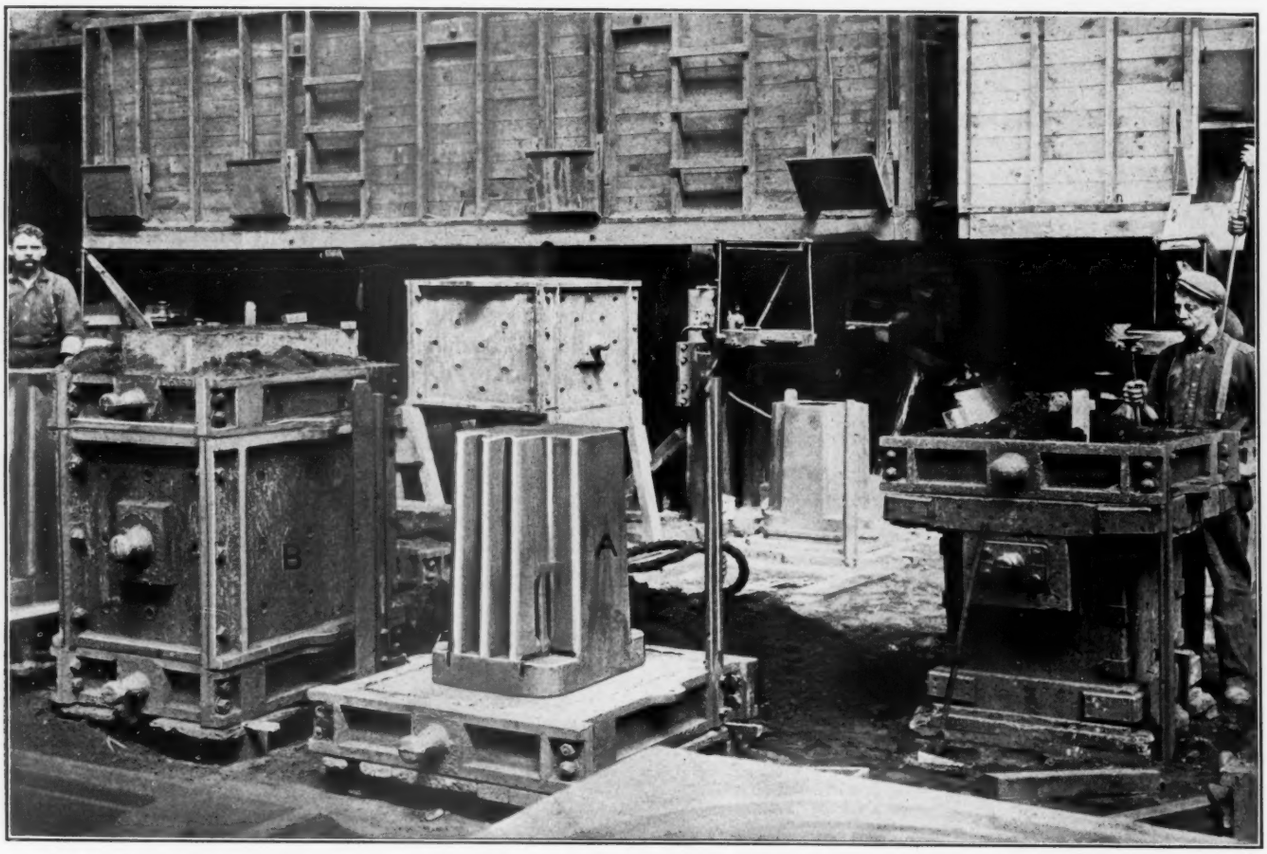


FIG. 10—THE DRAG HALF OF THE MOLD, WITH THE LARGE GREEN SAND CORE, IS SHOWN AT *A*; *B* IS THE MOLD READY FOR THE METAL AND AT THE RIGHT THE DRAG AND CORE ARE BEING RAMMED

are attached to either end of the bottom of the pattern plate for the links suspended by the bail. After the patterns have been drawn, the pattern plate is lifted away from the mold, as shown in Fig. 6. The mold and pattern plate suspended over the stack are shown in Fig. 7, which also illustrates the drag side of the preceding mold. Fig. 8 is a clearer view of the drag side of the mold containing two motor end rings. The sprue and two gates also are shown. The cast iron pattern plate, after being lifted away from the mold, is deposited on the wooden stand by the crane, and after being rolled over

Molding Transformer Boxes

To facilitate the molding of transformer boxes, the equipment shown in Fig. 9 has been installed by the Westinghouse Electric & Mfg. Co., at its Cleveland foundry. It consists of four drop pattern molding machines, previously described in THE FOUNDRY, and pneumatic riddles supported on posts which command each of the machines. The sand is stored in bins directly back of and over the machines. The openings in the bins for discharging the sand into the riddles are located directly above the molding machines. The bottoms of the bins are inclined toward these openings to facilitate the flow of the sand. Sheet steel spouts are hinged to the bins in front of the openings and when the doors of the bins are raised, the spouts are lowered and the sand is discharged into the riddles by gravity. Throughout the ramming operation the sand is riddled into the flasks, obviating the necessity of shoveling and riddling the sand by hand.

The commutator boxes vary in height from 24 to 36 inches and are molded in three-part flasks, the mold consisting of drag, cheek and cope. The drag carries the green sand core shown at *A*, Fig. 10, while the cheeks are rammed on the drop pattern molding machines. Both drag and cheek involve novel molding features and owing to the intricate contour of the commutator boxes, great skill was displayed in adapting this special molding equipment to this work. At *A*, Fig. 9, is shown a metal commutator box pattern, mounted on a drop

pattern molding machine, in raised or molding position. At the right a flask has been lowered over the pattern and the operator is ramming the mold. After the mold has been rammed, the pattern is lowered away from the mold by gravity following the withdrawal of several lugs automatically in the sides of the cheek. This section of the mold is next lowered over the drag, *A*, Fig. 10, containing the green sand core, and after setting and clamping the cope, the pouring basin is built up and the mold is finished as shown at *B*, Fig. 10. That great economies have been effected as the result of the adoption of this special equipment is indicated by the big increase in the output of these boxes. Formerly a molder and helper made one of these castings in a day, whereas the present daily production of two men consists of five molds. Each pneumatic riddle is supported by an arm, hinged to a post in such a manner that the riddle can be swung aside when not in use, or after the flask has been filled with sand.

The method of molding the drag and green sand core is indicated at the right, Fig. 10. The cast iron drag is set onto the core box, as shown, and after the ramming has been finished, the bottom board is clamped to the flask and the core box and flask are rolled over. In Fig. 12 the core box is being lifted away from the core, two cast iron posts on the drag flask serving as guides. The entire interior of the core box is collapsible and the removable parts remain in position on the core until they are lifted away by the molder. In Fig. 12 the removable core box sections which serve as the pattern for the core are in position and in Fig. 10, *A*, the core is shown after the loose pieces have been removed.

As a temporary expedient, a stripping plate also has been employed for lifting the mold away from the pattern. In this case the pattern remains raised or in a molding position, when lifting away the cheek. The stripping plate is underneath the flask, as shown in Fig. 11, and both the mold and stripping plate are lifted away by a crane. When the stripping operation has been completed about three-fourths of the height of the pattern, the stripping plate is supported and remains stationary while the flask is lifted away from the pattern the remaining distance. The rope slings are removed from the bottom of the plate and are readjusted for lifting the flask.

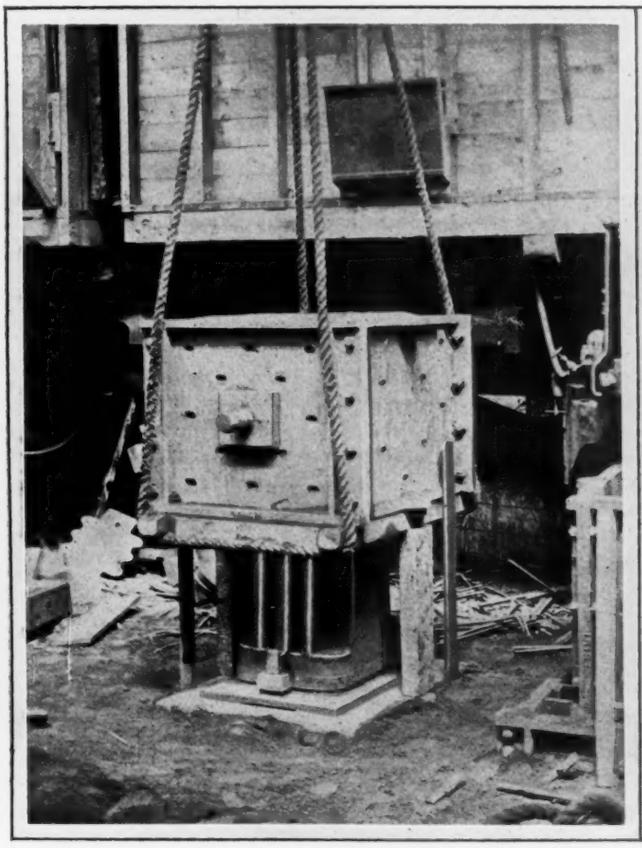


FIG. 11—LIFTING AWAY THE CHEEK OF THE MOLD BY THE USE OF A STRIPPING PLATE

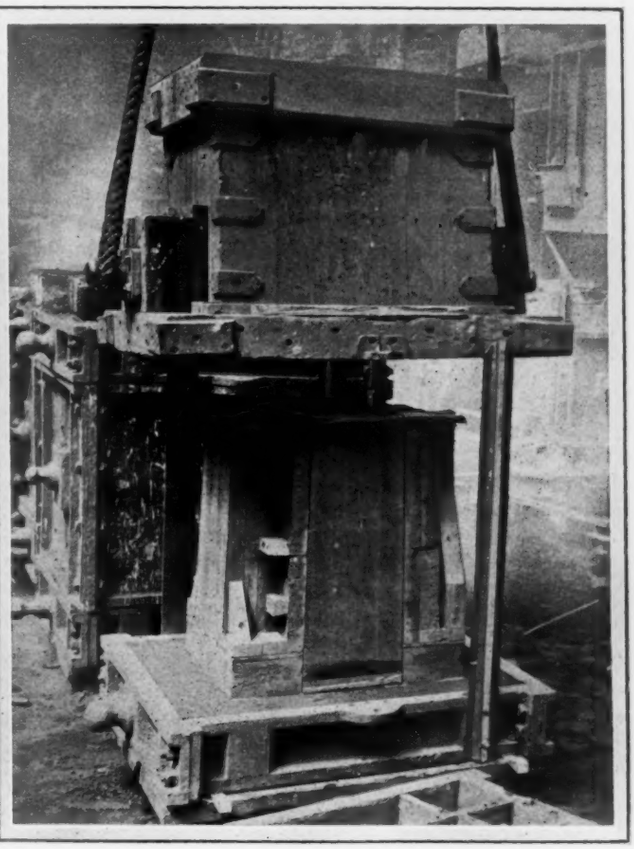


FIG. 12—LIFTING AWAY THE CORE BOX; THE LOOSE PIECES ARE IN POSITION ON THE CORE

Unveiling of Martin Fox Memorial

The unveiling ceremony of the Martin Fox memorial under the auspices of the International Molders' Union of North America will take place on the afternoon of July 5, at Cincinnati. This ceremony will in all probability be held before a large assemblage, as many of the most prominent men in the labor movement already have signified their intentions of being present. Thus far a total of over $3,000 has been subscribed, although a slight additional fund is required to defray the cost of the memorial.

Sales of jar-ramming molding machines have been reported by the United States Molding Machine Co., Cleveland, as follows: Bowler Foundry Co., Madison Foundry Co., and the Fulton Foundry Co., Cleveland, and the Medina Foundry Co., Medina, O.

The Prevention of Foundry Accidents

THE Prevention of Foundry Accidents was the subject discussed at the monthly meeting of the Chicago Foundrymen's Club, held at the Great Northern hotel, Saturday evening, May 11. President Wood opened the meeting with a few introductory remarks, in the course of which he sketched the scope and features of the new Illinois workman's compensation act and factory inspection laws. Mr. Wood said in part:

"The factory inspection law went into effect Jan. 1, 1910, and although effective for the past two years it has not caused a general disturbance only on account of the fact that the necessary appropriations for its complete enforcement were not made. This delay, however, is only temporary and it is merely a question of time until the foundries of Illinois will be regularly inspected by a state factory inspector who will insist on strict compliance with the law. The workmen's compensation act, which is now the subject of a great deal of attention in Illinois, compels the establishments electing to come under its provisions to pay fixed sums for classified injuries regardless of their cause, and notwithstanding the fact that statistics show that from 40 to 70 per cent of all accidents are every-day occurrences which are attributable neither to the employer nor employe. The employer who does not desire to come under the provisions of the law is deprived of the ordinary common law defenses in such cases. As a result of this legislation those firms in the foundry business which are carrying liability insurance are compelled to pay more than three times as much for their protection as heretofore. The regular foundry rate in Illinois before May 1 was $1 per $100 pay roll, but since May 1, when the workmen's compensation act became effective, it has been advanced to $3.40 per $100 pay roll.

"These terms impress upon the foundrymen the necessity of using every means in their power for the prevention of accidents. In the event of an accident in which it can be proven that the employer has failed to install reasonable safety devices, even though his plant is working under the workman's compensation act, the injured employe can have recourse outside of this law and sue for any amount he sees fit. There is no doubt that these laws have come to stay with probably some modifications of a minor nature and when it comes to reducing the insurance rates, this can only be accomplished by cutting down the number of accidents to a minimum, thus making the foundry a less hazardous risk."

Section two of the Illinois workman's compensation act states that the law applies to every employer engaged in any enterprise where molten metal or injurious gases or vapors or inflammable fluids are manufactured, used, generated, stored or conveyed in dangerous quantities. The employe who accepts the act can obtain only the compensation provided therein, except that when the injury was caused by the intentional omission of the employer to comply with statutory safety regulations, the act does not affect the civil liability of the employer, but the omission if the employer is a partnership, must be that of one of the partners, and if a corporation that of an elective officer.

Death Benefits

Section four provides that the compensation in case of death to lineal heirs to whose support the employe contributed within five years of his death shall be four times his average annual earnings, but not less than $1,500 or more than $3,500, weekly payments other than medical or surgical fees to be deducted from this amount. In case of disability, first aid, medical, surgical and hospital services shall be furnished, but medicine and hospital services for no longer than eight weeks, not to exceed $200. For disability for more than six working days the injured employe shall be paid half of his earnings, but not less than $5, nor more than $12 per week, as long as the disability lasts or until the amount paid equals a death benefit. In case of serious and permanent disfigurement to hands or face, not resulting in actual incapacity, an employe may resort to arbitration to determine a reasonable compensation, not to exceed 25 per cent of the death benefit. If complete disability continues after a payment of the sum equal to the death benefit or after the expiration of eight years, then a compensation during life equal to 8 per cent of the death benefit but not less than $10 per month, shall be paid. Employes are not allowed to contribute toward compensation.

Any person entitled to compensation shall have the same preferential claim against the property of the employer as is now allowed for unpaid wages or for personal services. Any contract made with an injured person or beneficiary within seven days of the injury is fraudulent. Noncompliance with the law is a misdemeanor punishable by a fine of not less than $10 nor more than $500 for each offense.

A paper entitled "Suggestions for Preventing Foundry Accidents" was read by W. H. Cameron, manager of the casualty department of the American Steel Foundries. Mr. Cameron exhibited a large number of spectacles worn by chippers and floggers which had been damaged by flying pieces of metal; had these spectacles not been worn the eyes of the workmen would have been injured in each case. Mr. Cameron's paper was published in full in the May issue of THE FOUNDRY.

Dr. A. N. Harvey, physician for the Crane Co., Chicago, spoke on the subject of foundry accidents. He pointed out that it is necessary to protect the worker against himself. He mentioned that the Crane Co. has had good success in preventing brass burns by requiring the men handling metal in the brass foundries to wear leather leggins. In the iron foundry care must be taken to keep the runner boxes on the flasks until the iron has had a chance to set. A number of accidents result from ladders being improperly placed and the Crane Co. has given this matter special attention. This company pays its workmen who are totally incapacitated through accident their full wages during the balance of their lives.

George H. Tompkins, attorney for the Chicago branch of the National Metal Trades Association, spoke on the legal aspects of accidents and pointed out some of the features of the new liability law which have been mentioned. A. M. Thompson, foundry superintendent of H. W. Caldwell & Son Co., told of a number of practical safety appliances for the prevention of accidents in foundries.

The Manufacture of Aluminum Match-Plates

Details of Goodale Co.'s Process With Interesting Examples of Complicated Work—Mixtures and Flasks Employed

By H Cole Estep

MOLDING with aluminum match-plates has been the subject of considerable discussion in the foundry trade during the past few years and the advantages of this process have been made so apparent that match-plates are now used not only for stove work, but less extensively for agricultural machinery castings, gun and sewing machine parts and miscellaneous purposes. The economies of the process, in stove plate work especially, are well known. One of the largest stove companies in the United States, which now has about 500 plates in operation, reports an average reduction in the cost of molding of over 50 per cent and the molders themselves earn higher wages than formerly. In addition, all expense for pattern repairs and the accompanying delays in production due to such repairs are eliminated when match-plates are employed. Also, by the use of match-plates, a saving of from 5 to 10 per cent in iron is possible, due to the fact that the molders are not able to rap the patterns down in the sand. Furthermore, the absence of rapping means that the castings are exact duplicates and perfectly interchangeable, obviating a great deal of the grinding and fitting necessary in assembling. In the shop of the McClary Mfg. Co., London, Ont., the piece price of a mold containing a wall register frame, 8 x 12 inches in size, was reduced from 20 cents to 11 cents by the introduction of match-plates.

Difficulties of Making Match-Plates

But before the foundryman can avail himself of the benefits of match-plate molding he must be provided with a suitable supply of plates. The difficulties encountered in making match-plates have been discouraging to many foundrymen and doubtless have prevented their introduction in a number of shops where their economy is self-evident. The plates require highly skilled workmanship and considerable care in their production and their manufacture involves the application of certain principles which are not always fully understood. Poor match-plates are worse than none at all. Although well made plates are the primary requirement, in a large shop where the investment involved is heavy, economy of production is almost equally important. It is not unusual to have from $3,000 to $10,000 invested in match-plates.

It is the purpose of this article to describe the methods and priciples involved in the manufacture of aluminum match-plates. For much of the information given we are indebted to the Goodale Co., Kalamazoo, Mich., specialist in match-plate manufacture. This company employs about 50 men who devote their entire time to making match-plates for the foundry trade.

The foundryman who wishes to rig up his shop with match-plates is confronted with two distinct problems. He must provide a set of plates to duplicate his existing standard castings. It is essential that the

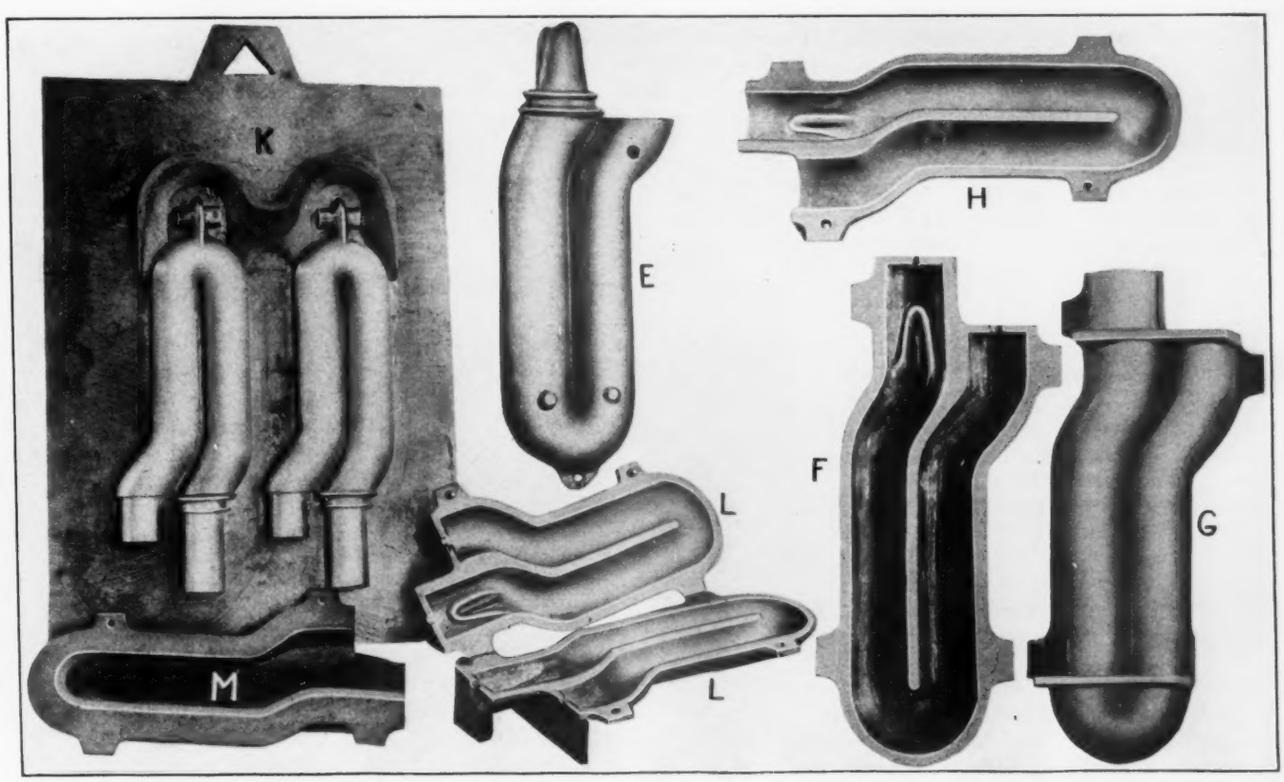


FIG. 1—EQUIPMENT FOR MOLDING GOOSE-NECK CASTING. *E*; *K* IS THE MATCH-PLATE; *L*, IRON CORE BOX; *G* AND *F* WOOD PATTERN, AND *H*, THE WHITE METAL CORE BOX PATTERN

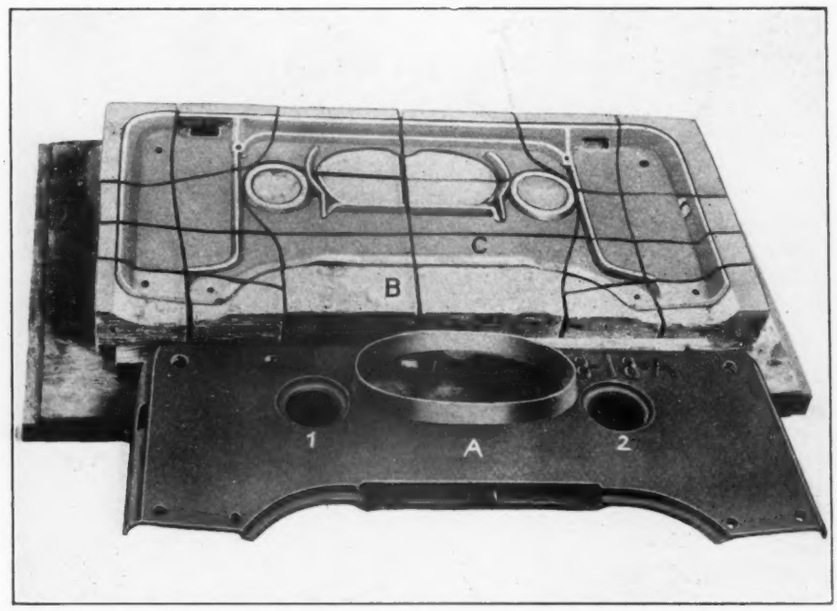


FIG. 2—SAMPLE CASTING OF COLLAR TOP IS SHOWN AT *A*; IN THE BACKGROUND ARE ILLUSTRATED THE ALUMINUM PLATE PATTERN AND PLASTER BACKING SAWED APART FOR SHRINKAGE ADJUSTMENT

castings made from the match-plates interchange with those made previously by other methods. He must also make plates for any new work not previously manufactured. The methods of procedure in each case are somewhat different and the former, although more complicated, is generally more important.

In making plates designed to duplicate existing castings it is necessary that the principal dimensions of the latter be known. For this purpose it is advisable to use sample castings, since it is rare that drawings are available showing the dimensions of the casting accurately, due to the inequalities in hand molding and patternmaking. As is well known, the dimensions of a casting molded by ordinary methods from a wooden pattern seldom coincide with those on the original drawing. Using the sample casting as a pattern a white metal alloy plate pattern is cast. After certain adjustments for shrinkage, that will be described in detail later, are made, this white metal pattern is used in molding the match-plate. Instead of a sample casting, the wood pattern may be used in making the match-plate. This method, however, is generally unsatisfactory, because the wood pattern contains allowances providing surplus metal at the fitting joints which are unnecessary in match-plate work. It is impossible for the match-plate maker to determine exactly how much these allowances are. Also it is not safe to measure a wood pattern and allow for the necessary shrinkage in order to obtain the dimensions of the finished casting, because the latter is not simply a duplicate of the wood pattern minus the shrinkage, but is somewhat larger, due to the fact that the molder raps the pattern down in the sand, slightly enlarging the mold. The amount of this enlargement cannot be determined from the pattern. Master patterns providing all the necessary shrinkage and other allowances may also be used in making match-plates, but they are seldom available. Plated castings should assemble with practically no filing, grinding or fitting in order to realize fully on the economies of match-plate molding. Such accuracy is impossible with ordinary patterns, due to the inequalities of hand molding.

Plates for New Castings

In making plates for entirely new castings, it is necessary to start with the drawing. In this case a master pattern is made out of wood or plaster of Paris and is used for molding the match-plate. In all branches of match-plate manufacture the problem of metal shrinkage is one of paramount importance. Proper allowances must be made not only for the shrinkage of the iron, but also for that of the master patterns and the match-plates themselves. If cores are necessary the shinkage problem is further complicated. The greatest care is necessary in order to obtain plates in which the proper shrinkage allowances have been made. This is one of the chief pitfalls that entrap the inexperienced match-plate maker. He finds that the castings made from his plates are not interchangeable and he seems unable to make plates which will produce castings of a certain predetermined size. As a result match-plate molding is often abandoned when a little knowledge of the shrinkage principles involved would solve the problem.

Figs. 2 and 3 indicate how the match-plate for the stove casting shown at *A*, Fig. 2, is made. This is known as a collar top, being that part of the stove to which the smoke

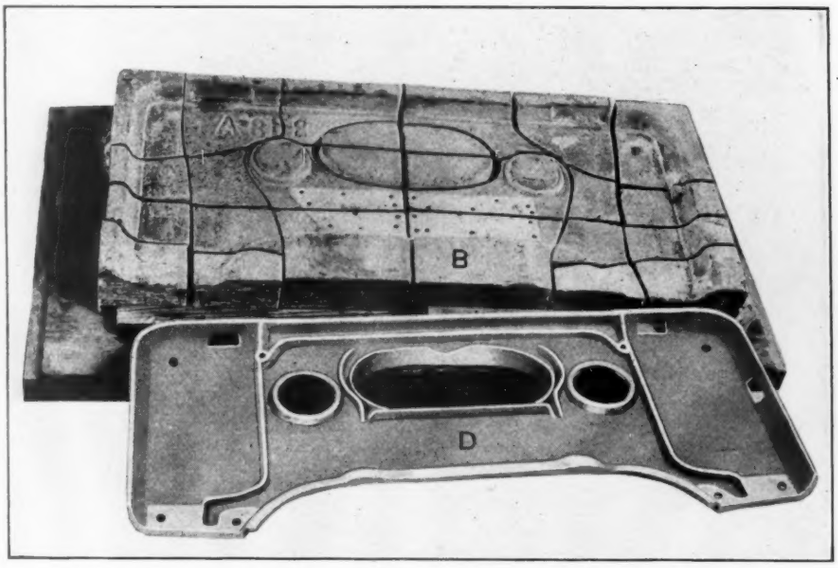


FIG. 3—THE ALUMINUM PLATE PATTERN SOLDERED TOGETHER AFTER THE SHRINKAGE ADJUSTMENTS HAVE BEEN MADE IS SHOWN IN THE FOREGROUND; *B* IS THE PLASTER BACKING CUT APART

pipe is fitted. The match-plate is designed to produce castings that are exact duplicates of the sample *A*, Fig. 2, which was made by the ordinary method; the castings coming from the match-plate will interchange with one another and with the old castings made by the hand process.

The first step in the process is to make a mold in sand using the plate *A*, Fig. 2, as a pattern. This is made in an ordinary flask in the usual manner and the mold is poured with a white metal alloy which is absolutely non-shrinking, producing the pattern plate *C*, Fig. 2. This, of course, is exactly the same size as the sample casting, but contains no allowance for iron or aluminum plate shrinkage. The proper adjustment for both of these factors is made by cutting the plate apart, as indicated in Fig. 2.

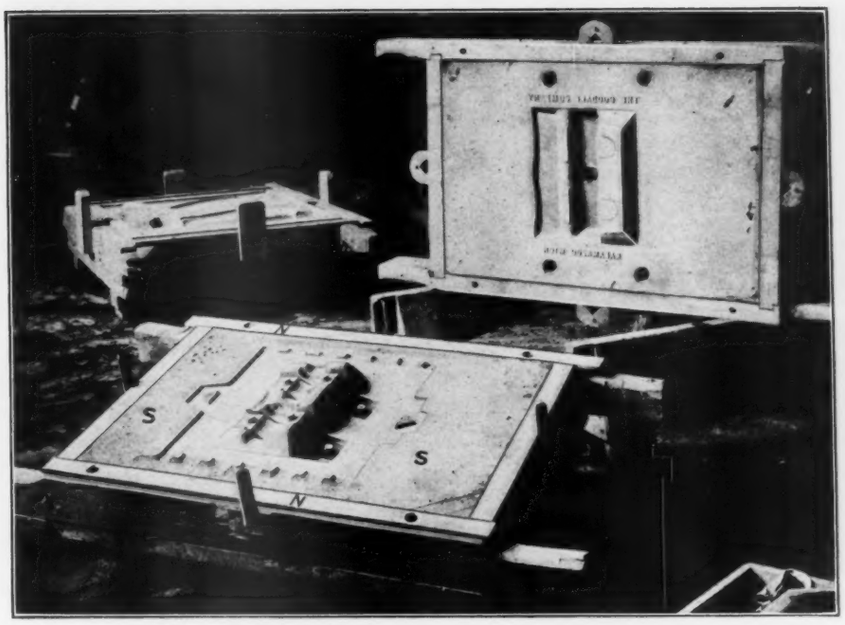


FIG. 5—A MATCH-PLATE MOLD, SHOWING WOOD STRIPS NAILED TO DRAG AND THE METHOD OF GATING

Cutting the Pattern

Before the pattern can be cut apart and adjusted it must be furnished with a follow-board so that the soft white metal plate will not warp or get out of shape. This follow-board is usually made of plaster of Paris for economy, one such being shown at *B*, Figs. 2 and 3. An exact parting is made in molding sand and boards are set on edge making a frame or box around the pattern and extending above the highest point of the pattern an inch or more so as to make a strong plaster block when completed. All the joints are closed with clay and a mixture of plaster of Paris and sharp sand is then poured into the box, the pattern having been previously brushed with oil to prevent sticking. The sharp sand is used only to save plaster and should be omitted for small intricate work. After the follow-board has dried out it should be leveled face up on a face plate so that when the pattern and follow-board are cut apart with a band saw and the segments separated for the correct shrinkage allowances, the plaster follow-board, although in pieces, will still support the pattern properly and prevent its getting out of shape.

On the collar top shown in Fig. 2, if the distance between the centers of the two cover plate holes, *1* and *2*, in the casting *A*, Fig. 2, is 18 inches, then the corresponding distance on the pattern plate before it is cut apart will be the same. To produce a casting of this size in iron the distance between the points *1* and *2* must be 18 3/16 inches in the finished match-plate, since the iron shrinkage is ⅛ inch per foot. However, the aluminum alloy from which the match-plate is made shrinks 5/32 inch per foot. Therefore, the total amount of shrinkage to be allowed in the white metal pattern is 9/32 inch per foot, or 27/64 inch for the 18 inches between the two points under consideration. But it would not be practical to concentrate all of this shrinkage allowance at one place on account of the bolt holes or other intermediate fitting points between the cover plate holes. Hence the pattern is cut into several parts and the total shrinkage adjusted among the segments so the proper secondary fitting points are retained, provision also being made for the total shrinkage between the two main points. This requires extremely careful workmanship. In like manner similar adjustments are made between the various principal points of the casting. It is not necessary that compensation be made for every point since only the fitting joints are of consequence in assembling.

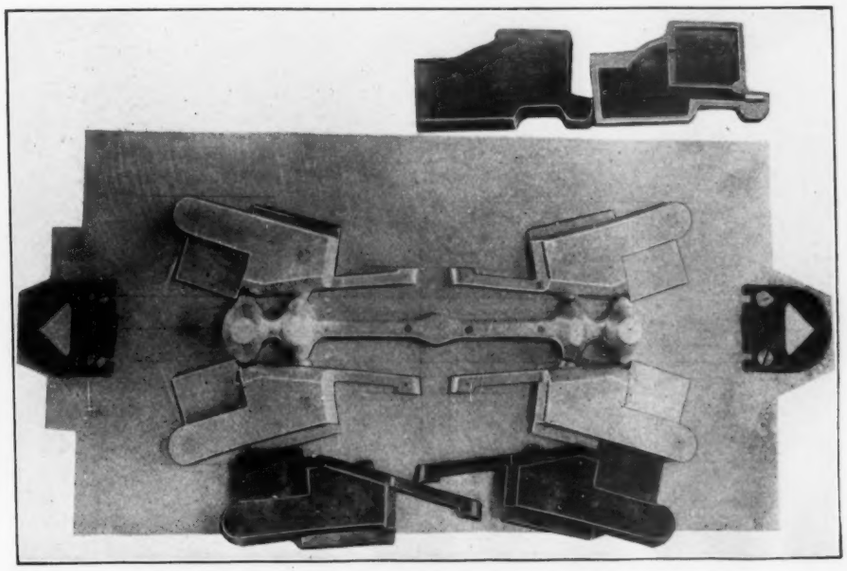


FIG. 4—MATCH-PLATE, WOOD PATTERN AND CORE BOXES OF GUN PARTS

Soldering the Pattern Together

Although Fig. 2 shows the white metal pattern cut into a large number of pieces, it should not be concluded that all these cuts are made at one time. In reality each cut is made separately, the proper allowance for shrinkage provided and the pattern then soldered together in the new position before the next cut

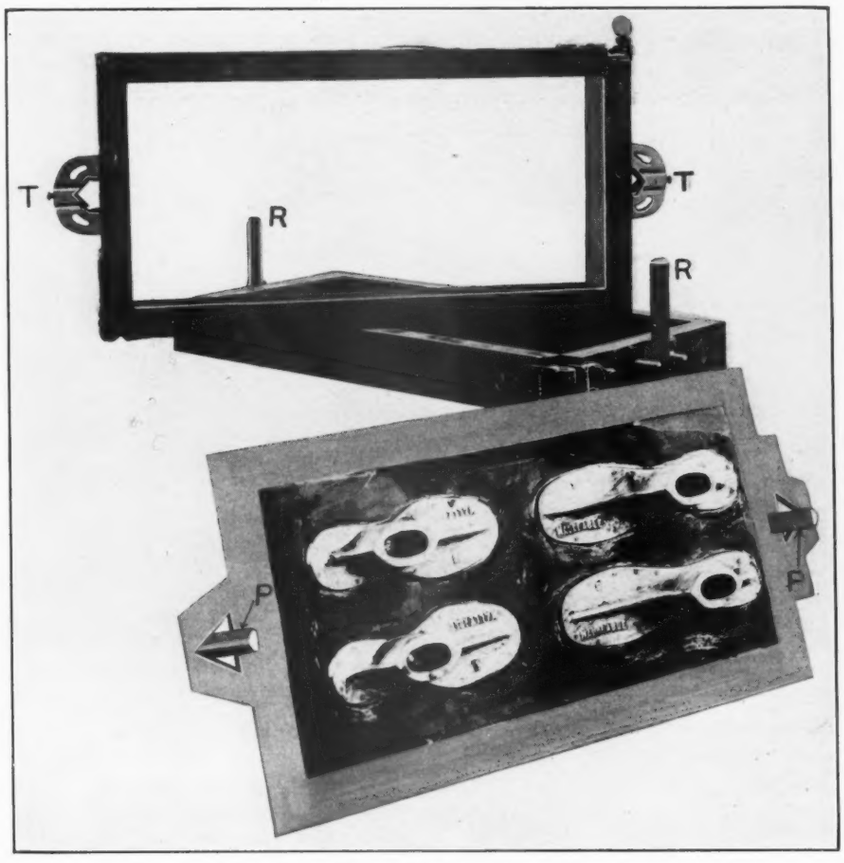


FIG. 6—IMPROVED MATCH-PLATE PIN AND SNAP FLASK

is taken. Before any cuts are made, of course, the whole job must be laid out and the position of the various cuts determined. In soldering the pattern together a common soldering iron is used. The alloy melts at a low temperature and welds autogenously. Of course, the same result could be obtained by measuring the sample casting and making a wood pattern embodying the necessary shrinkage allowances. This, however, would be a much more expensive operation than simply casting the white metal plate, sawing it apart and adjusting the principal dimensions as described above. Also the wood pattern warps and shrinks in the sand producing an inaccurate plate.

The pattern plate, *D*, Fig. 3, is then taken to the foundry and a match-plate mold made with it in the ordinary manner. This mold is cast with an aluminum alloy shrinking 5/32 inch per foot so that the match-plate will produce an exact duplicate of the original casting.

Making Match-Plate Molds

Fig. 5 shows how the match-plate molds are made. The pattern plate is placed on the bottom board and the drag is rammed and rolled over in the usual manner. The cope is then fitted, rammed and removed. The best fine, high-grade molding sand is used and great care is taken in ramming the molds, which are as soft as possible. A skilled molder is a necessity in work of this sort if proper results are to be obtained, since the partings must be retained accurately. When the main portions of the mold have been completed wood strips, *N*, Fig. 5, are nailed on the drag. They are the same thickness as the match-plate and the sand, *S*, is filled in the parting forming the outlines of the plate. The gates, which are clearly shown in the drag, together with the runners and risers in the cope, are then cut and finished and the mold is closed ready for pouring. When molding standard match-plates instead of wood strips an adjustable or solid steel frame may be used and will be found more economical and satisfactory. Before the molds are closed they are carefully dried by the heat from a red hot iron plate.

Pattern Plate Mixtures

The pattern plates are generally made from an aluminum and spelter mixture, while the non-shrinking white metal is a mixture of tin, lead, antimony and bismuth. The details of these mixtures vary greatly for the different plates and each match-plate maker is generally required to work out the problem for himself. A large foundry in the west uses the following mixture for its plates: Six parts aluminum, one part zinc and one-half part bismuth. The aluminum and zinc are melted together first and the bismuth is added to the molten mixture. This mixture will shrink. Another match-plate maker uses a variation of Prof. Carpenter's Alzin mixture in making the pattern plates. This consists of two parts aluminum and one part zinc, to which a small amount of copper is added.

The production of good match-plates requires considerable skilled labor in finishing and fitting. Also it is not economical to cast small patterns on the plate, but it is more

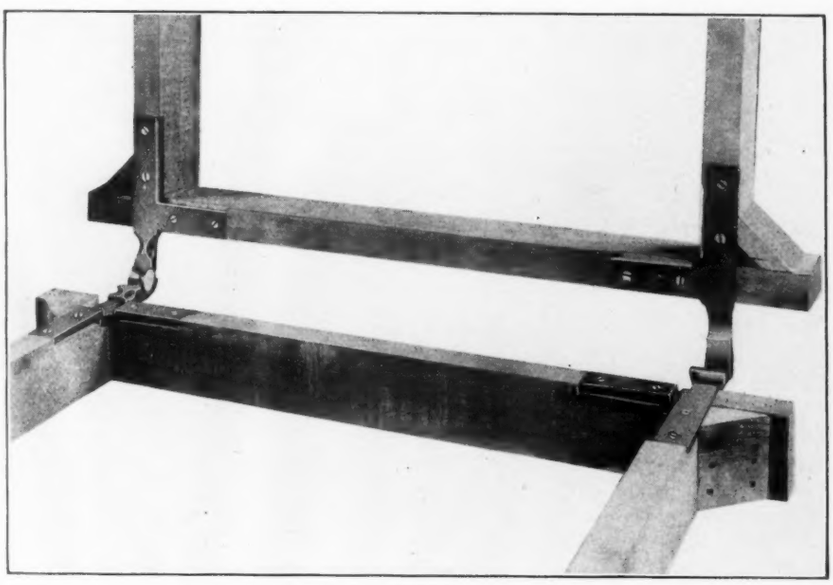


FIG. 7—THE GOODALE ROLL-UP FLASK HINGE

convenient to rivet or screw them to it. Fig. 9 shows a portion of the Goodale Co.'s finishing shop and indicates the nature of the equipment necessary for this part of the work. Special vises which may be adjusted in any position are used. Skilled mechanics are required and the following machine tools are used by the Goodale Co.: 18-inch LeBlond engine lathe; 36-inch band saw provided with wood and metal saw blades; wood cut-off saw, drill presses, polishing machine, surface grinder, flexible shaft grinder, plane table and wood turning lathe.

FIG. 9—FINISHING DEPARTMENT IN THE PLANT OF THE GOODALE CO.

Match-Plate for Goose-Neck

Fig. 1 illustrates the details involved in making a match-plate for a goose-neck. Since the casting is hollow and cores are necessary, the process involved is more complicated than that for making the collar top shown in Fig. 2. The casting which is to be plated is shown at *E*, Fig. 1, and the finished match-plate at *K*. A wood pattern was necessary for this job, the interior and exterior of which are shown at *F* and *G*. The measurements necessary for making the pattern were taken from the sample casting, *E*. The pattern is enough larger than the sample casting to allow a shrinkage of 5/32 inch per foot in the aluminum alloy match-plate. The iron shrinkage of ⅛ inch per foot is, of course, also provided for in the pattern. The pattern is made hollow and of the exact thickness required in the iron casting, as shown at *F*, and therefore serves the purpose of a core box. As soon as the pattern was completed, castings in aluminum were made from each of the halves. These half castings were fastened together, finished and mounted on the plate, together with the gate, as shown at *K*.

After the pattern had served its purpose in molding the goose-necks for the match-plate it was transformed into a core box pattern by enlarging the ends for the core print and adding ribs and lugs. Since a large number of cores were necessary a number of core boxes had to be provided and it was advisable that they be made from a material which would stand hard wear. Cast iron was, therefore, employed, and in their finished form the boxes appear at *L*, Fig. 1. This view also shows the cast iron frame on which the core box is supported.

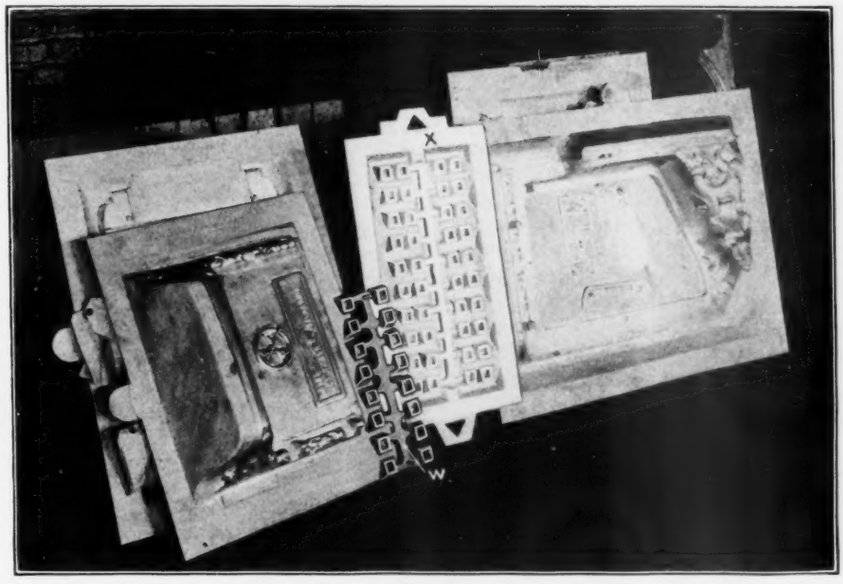


FIG. 8—A GROUP OF LARGE MATCH-PLATES

The patterns, *G* and *F*, Fig. 1, as previously mentioned, had a white metal shrinkage allowance of 5/32 inch per foot. If the iron core boxes, *L*, Fig. 1, were cast directly from the patterns, *G* and *F*, there would be a discrepancy of 1/32 inch per foot, since the iron shrinkage is only ⅛ inch. It was, therefore, necessary to take an intermediate step, and metal core box patterns similar to the one shown at *H*, Fig. 1, were cast from the wood patterns. They were made out of a white metal alloy with a shrinkage of 1/32 inch per foot. The pattern *H* was used to mold the iron core boxes, *L*. The shrinkage at *H* being 1/32 and of *L* ⅛ inch, the total is 5/32 inch, equivalent to the shrinkage allowance in the wood pattern, thus making it certain that the core boxes correspond in size with the match-plate *K*.

In addition to the boxes a large num-

ber of dryers were required for holding the cores while they were in the oven. These were made simply by casting duplicates of the white metal pattern *H*, Fig. 1, in iron. Finally a venting plate, *M*, was provided. As shown in the illustration, this plate contains a rib, an impression of which is made in each half of the core before the box is closed, thus forming a continuous channel through the axis of the core for the escape of gases.

Match-Plate Made From Drawings

Fig. 4 shows a match-plate made direct from drawings for a set of new castings. There are four castings on the plate. The patterns used in making the plate are shown at the bottom of Fig. 4 and the interior and exterior of a core box for these castings is shown at the top. The plates were ordered by a gun manufacturer, the castings being portions of the breech block of a repeating rifle. In producing this match-plate it was simply necessary to make a wood pattern allowance being made for the shrinkage of the aluminum and the iron. Aluminum castings were made from the pattern and fitted to the plate as shown in Fig. 4. This illustration also shows clearly the method of gating employed. The various small parts are fastened to the plate with screws, the heads of which have been filled. It is desirable in match-plate work to have the gates separate from the other portions of the mold so that changes in gating may be easily made at a subsequent date if advisable. Instead of a wood pattern, such as that shown in Fig. 4, it is sometimes more economical to make the pattern out of plaster of Paris. The plaster patterns are shellaced to make them moisture-proof and when so treated may be left in the mold over night. This, of course, is impossible with a wood pattern.

Large Match-Plates

A group of large match-plates made by the Goodale Co. is shown in Fig. 8, and special attention is directed to the one marked *X*. This was made from the gated pattern, *W*. It will be noted that whereas there are only 16 castings on the pattern, there are 40 on the match-plate which can be molded at no greater expense. Sometimes match-plates are made hollow and fitted with mechanism for punching out lugs or other small projections in the mold. The Goodale Co. has made several plates of this sort for molding small stove covers. Every stove lid, or cover, contains a socket equipped with a couple of small lugs in which the lifter is inserted. The match-plates are designed to mold eight small lids at one time and are provided with a punching mechanism which automatically molds the lugs at one operation. The old piece price for this work was 2 cents per cover and now the entire match-plate of eight covers is molded for 2¼c.

Trouble will be experienced in the use of match-plates if proper flasks are not provided. Fig. 6 shows a special snap flask for match-plate work designed by the Goodale Co. The drag is equipped with two hollow milled pin sockets, *R*, which engage the pins, *P*, fitted to the plate. The latter are not rigidly attached to the plate, but are suspended on a strip of spring brass so that a tight fit and a steady draw is assured. The pins, *P*, fit in the sockets, *R*, and the lugs, *T*, on the cope, slide over both. With this arrangement there is no danger of spoiled work resulting from carelessness in drawing the plate from the mold. The plate shown in Fig. 6 contains four patterns for malleable iron shoe lasts.

Roll-Up Hinge

Many match-plates are hinged and for this class of work the Goodale Co. has designed a flask and plate hinge, the details of which are clearly shown in Fig. 7. The groove in the left-hand hinge holds the two parts of the flask in alignment and prevents any lateral motion. The right hand hinge is nothing more than a plain roller and the combination of the two automatically takes care of any expansion or contraction in the flask. The sockets for the plate hinge are shown clearly and the hinge itself is similar to the flask hinge except that it is provided with a stop which locks the plate to the drag while the cope is being rolled up.

In order that the foundryman using match-plates may have an accurate knowledge of their economy, it is always advisable to keep a careful record of the cost of making the plates. This record should include all the elements which enter into the problem. It is not sufficient simply to add the labor cost to the cost of the metal, the proper proportion of overhead charges should be included, together with the melting losses, cost of fitting up the flasks, etc.

Although properly made match-plates will stand a large amount of abuse, the best results are always obtained when the equipment is given reasonable care. Since many plates are expensive they should preferably be stored in a fireproof vault so arranged that the air circulates freely. It is generally best to stand the plates on edge and the room should be fitted with racks so that they do not come in contact with one another. It is not considered good practice to let the plates lie around on the floor over night. Instead they should be put in the vault at the close of each day's work.

American Institute of Metals

The name of the American Brass Founders' Association, by an overwhelming vote of its membership, has been changed to the American Institute of Metals. In addition, a change in the by-laws has been made which provides that the Institute shall meet in convention each year at the time and place selected by the executive committee instead of the time and place chosen for the annual convention of the American Foundrymen's Association. The American Institute of Metals will hold its annual meeting in Buffalo during the week of September 23, when the foundrymen's organizations will meet. Headquarters have been established at the Hotel Iroquois, where the meetings of this society will be held. The American Foundrymen's Association has selected the Hotel Statler for its headquarters and the Foundry and Machine Exhibition Co., the Lafayette hotel.

A large number of papers already have been prepared and those already received by the program committee follow:

"The Rare Earth Metals with Especial Reference to Pyrophoric Alloys," by Dr. A. Hirsch.

"Phenomena Connected with the Tarnishing of Metals," by Prof. C. F. Burgess.

"Vanadium Alloys," by G. L. Norris.

"Work of the Bureau of Mines as it Relates to Non-Ferrous Metal Industry," by Prof. C. L. Farsons.

"The Practical Use of Equilibrium Diagram," by Dr. W. Campbell.

"The Difficulties Experienced in Casting German Silver," by C. P. Karr.

"The Electric Furnace for Brass and Bronze, and Its Efficiency," by G. H. Clamer.

"The Influence of Pouring Temperature on Manganese Bronze," by H. W. Gillett.

"The Successful Handling of Manganese Bronze and Other Alloys in a Reverberatory Furnace," by W. R. Dean.

"Progress of Work on Boron Suboxide as Used as a Deoxidizer in Non-Ferrous Metals," by E. Weintraub.

Papers also are being prepared by Dr. W. R. Whitney and W. S. Landis.

In a four-page circular, R. Ardelt & Sohne, Eberswalde, Germany, engineers and manufacturers of foundry equipment, illustrate and describe a continuous cast iron pipe shop, as well as equipment used in the operation of plants of this kind. This company likewise builds cranes of all types for iron and steel foundry use.

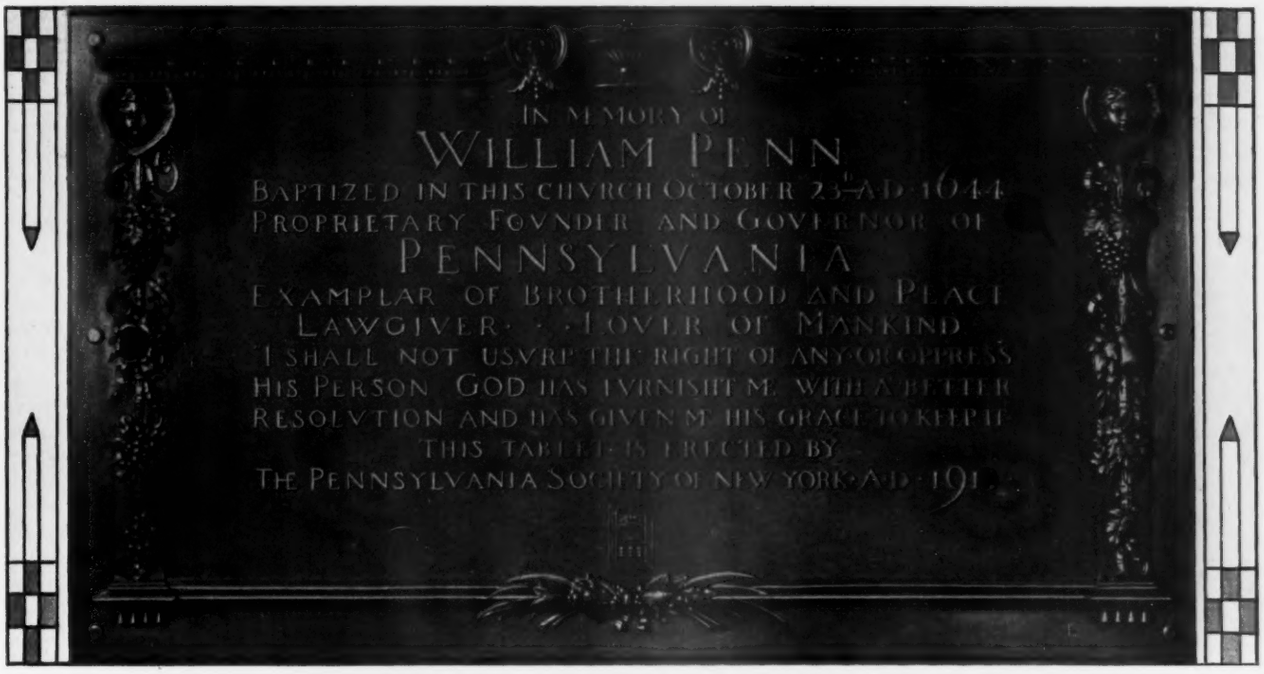

IN MEMORY OF
WILLIAM PENN
BAPTIZED IN THIS CHVRCH OCTOBER 23 AD 1644
PROPRIETARY FOVNDER AND GOVERNOR OF
PENNSYLVANIA
EXAMPLAR OF BROTHERHOOD AND PEACE
LAWGIVER · · LOVER OF MANKIND
I SHALL NOT VSVRP THE RIGHT OF ANY OR OPPRESS
HIS PERSON GOD HAS IVRNISHT ME WITH A BETTER
RESOLVTION AND HAS GIVEN ME HIS GRACE TO KEEP IT
THIS TABLET IS ERECTED BY
THE PENNSYLVANIA SOCIETY OF NEW YORK A D 191

Fig. 1—Penn Memorial Tablet, Erected in London, Eng.

Molding Architectural Bronze Castings

By C Vickers

HIGHLY artistic castings are very difficult to mold on account of the many undercut sections of the design, which necessitate the employment of false cores, wax patterns and other refinements of molding, unnecessary when molding patterns having straight draft. The use of undercut sections cannot be avoided when, scrolls, wreaths, leaves, flowers, fruit, drapery and human and animal figures comprise the design, and the more nearly these adornments approach the natural, the more difficult they become to reproduce in metal. Consequently, the three most essential qualifications for success in this branch of the founder's art are time, patience, and skill. The various operations cannot be carried out with the speed that often characterizes ordinary foundry work, especially, as is frequently the case, when the mold is built-up of many small sectional cores. Patience, therefore, is essential, and must be cultivated by the foundryman accustomed to ordinary methods of molding and who is desirous of mastering the higher branches of his art. A good idea of the intricacies of this work may be obtained by studying the accompanying illustrations. A beautiful example of the founder's art is illustrated in Fig. 3. This shows one of the bronze newel posts of the main balustrade of the staircase erected at the residence of Benson B. Sloan, New York City. The bronze work was executed by the Henry Bonnard Bronze Co., Mount Vernon, N. Y. While this newel post was not made in one section, the difficulties involved in producing the castings will be appreciated by those skilled in the art of molding. Another bronze which combines both artistic design and skill in founding is illustrated in Fig. 2. This bronze lamp standard commands the post office at Elizabeth, N. J. The height of the standard, including the glass globe, is approximately 14 feet. The subdued design of the bronze door, Fig. 5, is sufficient evidence of its purpose. It is the door of a vault in Woodlawn cemetery, New York City. With the exception of the embellished molding at the bottom of the door, the ornamentation is entirely confined to the panel and is especially appropriate. The keyhole is guarded by a large bronze beetle, exceedingly life-like, and the handle of the door harmonizes with the rest of the design. The door panel has a rough finish, which requires skillful molding and the use of high grade metal. This door and the William Penn Memorial Tablet, Fig. 1, were made by the Henry Bonnard Bronze Co. The tablet is 5 feet, 10 inches long, and 3 feet, 4½ inches high. It was erected at London, Eng., in 1911, and was the gift of the Pennsylvania Society of New York. Some very large castings are occasionally required for architectural purposes, and even when plain and devoid of ornamentation, skillful molding is essential to their successful

Fig. 2
Bronze Lamp Standard

Fig. 3
Bronze Newel Post

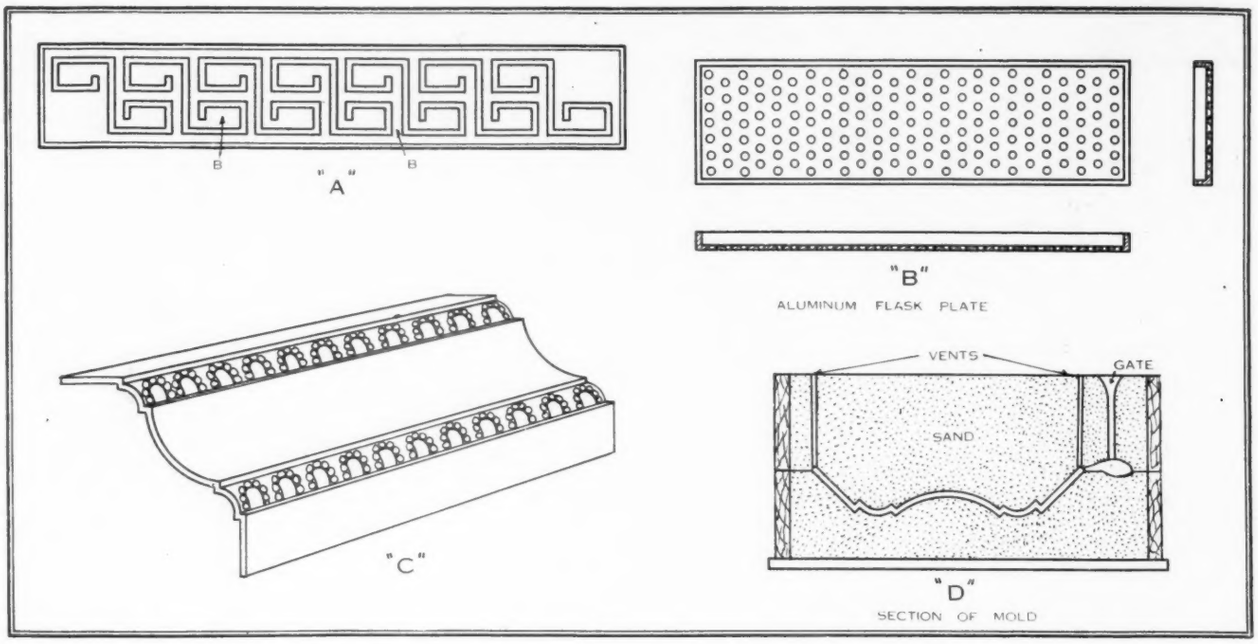


FIG. 4—EXAMPLES OF ARCHITECTURAL BRONZE WORK, CROSS-SECTION OF A MOLD AND DETAILS OF AN ALUMINUM PLATE FOR A BUILT-UP FLASK

production. Long and thin moldings are always difficult castings to make, although the ornamentation is seldom undercut. These castings are subject to many defects, such as ramming-away, straining, failure to run, blows, scabs, roughness, the washing of small cores, and the cutting of the sand by the metal. A strong, smooth facing is required for the mold, especially in the case of such raised ornamentation as shown at *A*, Fig. 4. The small cores, *BB*, cannot be nailed in a mold for a 10 or 15-foot molding, and if one of them hangs in the sand when drawing the pattern, or is displaced when cleaning the mold, considerable trouble will be experienced when patching them in place. It follows, therefore, that such patterns should be carefully drafted, so that there are no undercut, straight, or rough places to tear away the cores. This point cannot be too strongly emphasized, as it is frequently lost sight of, and the founder has to take the blame for the ensuing rough castings. When a number of moldings are required, a metal pattern is a good investment, as a wood model cannot be prevented from springing in the mold, thereby destroying the impression, and causing endless trouble and loss of time. With a well-finished metal pattern, a fine smooth facing of high bonding power and a properly constructed metal flask, three-fourths of the difficulties encountered in making these castings will be overcome. Difficulties frequently experienced are largely due to inadequate equipment, and the expense incident to fitting-up for the work will be money well invested in all cases where a large number of castings are to be made from one pattern. It is usually advisable to skin-dry the molds for long, thin castings, as it facilitates the flow of the metal, preventing mis-runs, cold-shuts, scabbing and the washing away of the cores. The best points to locate the gates are on the ends, although this will depend upon the thickness of the castings. It is obvious that a casting 3/16 inch thick and several feet in length cannot be run entirely from the end and side gates are necessary. It is surprising, however, how far the metal will run in a long, thin casting when poured from the end with the flask properly inclined. It can safely be said that many castings are gated on the sides, which could be poured with better results from the ends. When pouring long, thin castings, it is occasionally necessary to elevate the pouring end of the mold a height of 2 feet. In this case a riser is taken off at the lower end and the head is built-up sufficiently to prevent the metal from running out before the pouring head is filled. Whenever there is reason to assume that a casting can be poured from one end by inclining the flask, it will generally pay to try one mold, even if the casting is lost. If the method proves successful, better castings will be obtained, and the labor of cleaning will be reduced to a minimum. If the casting is too long or thin to be run from one end, regardless of the inclination of the flask, it is better to gate it at the side than at both ends, which involves pouring with two pots. When two crucibles are employed for pouring, it is probable that a large percentage of the castings will be more or less cold-shut in the middle, where the two streams meet.

FIG. 5—AN ARTISTIC BRONZE VAULT DOOR

Numerous arguments could be advanced to prove the superiority of the end gate, but in spite of its manifest advantages, it cannot always be employed and side-gating becomes neces-

sary. This is usually the case with castings similar to the one shown at *C*, Fig. 4. These sections are molded face down, as shown at *D*. The side gate entails the use of a wide flask, and if the latter is made of wood, a wide margin of safety should be allowed between the runner and the side of the flask, as the pressure on the joint is very great while pouring. If the metal breaks out and burns the joint of the flask, not only is that particular casting lost, but others are endangered and may be lost from the same cause, unless the burned part of the flask is cut out, and a new strip fitted in place.

Care should be exercised when beginning such work to prevent the possibility of the metal breaking through the sides of the flask, not only on account of the loss of metal entailed, but because of the moral effect on the pourers. These castings, because of their light section, must be poured with a decision that is always founded on confidence, and if the latter is once shaken by a run-out, other losses may be expected, due to indecisive pouring which produces mis-run and cold-shut castings.

Use of Metal Flasks

Metal flasks, while highly desirable and effective in preventing run-out troubles, are often too heavy and awkward, when of large size, for extensive use in brass foundries. This difficulty can be overcome, however, by the use of cast aluminum, which is an excellent material from which to construct flasks for brass foundry use. The flasks can be built-up conveniently from flat, flanged slabs, closely perforated to hold the sand and to carry off the gases. A pattern of a standard length can be made, as shown at *B*, Fig. 4, and the aluminum slabs can be bolted end to end to form a flask of any desired length.

Short sections can be cast from the same pattern by stopping-off the unnecessary length and by using a movable flange. The cross bars also can be cast in aluminum, and should be provided with flanges for bolting them to the sides of the flask. The bars can be perforated to save metal and to hold the sand. If there is no further use for the aluminum flask after the order has been completed it may be dismantled, the sides stored for future use, and the bars returned to the melting pot.

Casting Pure Copper in Sand Molds

FROM the viewpoint of the electrical engineer, the application of boron marked a new era in the production of copper castings for electrical purposes, as by its use the standard of conductivity of cast copper has been raised to a point hitherto impossible to attain. The announcement of the discovery and its application excited widespread interest, as well as considerable skepticism among brass founders generally, but time has shown that the claims then made had a foundation of fact, and that practically pure copper castings have become a commercial possibility.

Pure, untreated copper cannot be cast in sand molds without obtaining defective castings. It is absolutely necessary that it undergo some treatment to eliminate the gases absorbed during melting, otherwise the castings will be honeycombed; the metal is so wild, that after the molds are poured, it will flow back again out of the pouring heads, or the latter will swell and liquate to such an extent that they resemble cauliflowers. The porosity of the ensuing castings may vary in degree from minute pinholes to large holes, according to the amount of the impurities contained in the copper, and their influence thereon. This difficulty can only be overcome by adding to the copper some metal or element that will combine with the oxygen and remove it as a slag or oxide, and with the exception of boron, nothing has been discovered that will do this and will not at the same time alloy with the copper if added in excess of what is required to remove the oxygen. In all cases the alloy so formed will be lower in electrical conductivity than the original copper.

Lowered Electrical Conductivity

This lowering of conductivity necessitates an increase in the cross-sectional area of the casting, to carry the same current, over that required in the case of pure copper, and this increase in the size of the casting increases its cost in proportion to the added weight. Therefore, if the conductivity of the cast copper is only 50 per cent of the theoretical efficiency of pure copper, this means a casting twice as large, and hence twice as costly as would have been required in the case of copper of the highest electrical efficiency. The consumption of copper castings for electrical purposes is large and is continually increasing, several hundred pounds being frequently used for one switchboard in the shape of bus bars, studs, and other castings. Consequently, any improvement in the electrical conductivity of the castings is greatly to be desired, as it would be followed by great economies due to the reduction in the consumption of copper, and many advantages from the reduction in weight.

The Use of Zinc

Many patents have been granted for making solid copper castings, and many curious methods have been proposed, but the old and reliable method is the use of zinc, in quantity dependent on the skill with which the copper is melted. The result is an alloy of low conductivity, but easy to cast and useful for many purposes where conductivity is of no importance. Phosphorus is also used for the same purposes as zinc, but with no better results as far as conductivity is concerned. The first real step forward, came with the advent of silicon-copper about 20 years ago. This alloy is a product of the electric furnace, but its introduction was a slow process, and it is only within the last few years that it has come into general use. Silicon-copper, however, left something to be desired from the viewpoint of electrical conductivity. With skillful manipulation high conductivities are stated to have been obtained, but generally speaking this property ranges only from 50 to 60 per cent of that of pure copper, and is sometimes less when a large quantity of the deoxidizer is used.

For a time magnesium seemed to offer great possibilities in the way of obtaining copper castings of high conductivity. Unfortunately, however, its use requires such skillful manipulation, that the average founder experiences so much trouble from unsound castings, that in spite of the excellent conductivity of such of the castings as are sound, this deoxidizer has failed to supplant silicon-copper to any large extent.

Boron is added to molten copper in the form of a powder consisting of boron, boric anhydride and magnesium. Boron is allied to carbon,

and occurs in the same modifications, namely the crystalline, graphitic and charcoal forms. It is in the latter condition that it exists in the powder used for deoxidizing copper, and which is known as boron suboxide. The magnesium is originally used to reduce the boron from the boric anhydride, and a certain proportion of both these substances remain as a residue, and apparently exercise no harmful influence, as by the use of this material as a deoxidizer, sound and perfect castings are obtained by ordinary methods of molding. The chief drawback to the use of boron suboxide at present is its cost. The use of this substance increases the cost of the metal in the furnace 2½ cents per pound. After charging off the gates, risers and losses it amounts to approximately 5 cents per pound added to the cost of the finished castings. This cost is almost prohibitory and may so restrict its use that boron will be forgotten and the place it might occupy will be taken by some other element capable of producing closely similar results at a reasonable cost. There may be numerous elements that will produce copper castings, sound and of high conductivity, as there are many primary substances to be investigated, but as far as present developments have gone the most promising is titanium. This element is better known to steel and iron foundries than to brass foundrymen, but it is now being introduced as titanium-copper, one-fourth of 1 per cent of which will produce solid copper castings, possessing conductivities ranging from 90 to 96 per cent. This is considerably higher than is usually obtained by the use of magnesium.

BRASS FOUNDRY DIFFICULTIES

Solved by Experts

Leaks in Brass Pipe Fittings

We make water pipe fittings and subject them to a water pressure test before shipment, and we are greatly troubled with leaks, the loss being as high as 10 per cent. In some of the castings, the water merely sweats through, in others the leak bcomes a fine needle spray. To all appearances the castings are good before being tested. We use all scrap metal, mostly wire cloth from paper mills, which contains about 80 per cent copper and 20 per cent zinc, to which we add about 3 per cent of lead. The metal is melted in pit furnaces, in No. 60 crucibles. It is kept covered with charcoal and the castings are poured hot. With cool pouring the leaks greatly increase. The cores, which are bonded with flour, are made as weak as possible. We have tried other binders without any improvement. We also tried the addition of 5 per cent of tin to the mixture, but strange to say, the leaks increased. The molding sand is No. 0 Albany. If you could suggest a more economical mixture for these fittings, that would give a higher percentage of sound castings, we would greatly appreciate the same.

It is highly probable that the source of this trouble lies in the use of the wire cloth, as this material in melting exposes a relatively enormous surface to the action of the furnace gases, from which it absorbs sulphur and oxygen. These impurities cause dross, which is absorbed by the alloy and is carried into the castings, producing planes of weakness through which liquids are able to force their way. Porosity, in nearly every case, arises from the small source, the absorption of deleterous gases and particularly oxygen, while the metal is being melted. This is proved by the fact that changes in the manner of molding and gating the castings, in the grade of sand, the application of skin-drying and baking to the molds and so forth, make no difference in the ultimate result, as the trouble may disappear for a time, only to re-appear later, like a disease suppressed, with greater virulence. In order to use this metal, and secure the highest results it should be melted with the addition of from one-fourth to one-half of 1 per cent of 30 per cent phosphor-copper, the latter being added after the scrap brass has become liquid, after which the metal is poured into ingots, which are afterwards remelted under charcoal for the castings.

Aluminum should be carefully excluded from the metal, as its presence would cause drossing and consequent porosity. The manner in which the castings are being gated may be responsible for the trouble to some extent, and in order to overlook no possible cause, a test could be made by gating several heats differently, and the results carefully noted. Concerning the mixture, there is no valid reason why the percentage of zinc should not be increased. The color of the metal will not be greatly affected, as it will continue to be yellow. We suggest the use of from 15 to 20 pounds of zinc, 3½ pounds of lead and 1½ pounds of tin to every 100 pounds of the remelted wire cloth, or its equivalent in scrap with the addition of a small percentage of phosphor-copper.

Lead, Silicon and Aluminum in Brass

We have a large number of small padlock castings to make, and have been using the following alloy: Copper, 64 pounds; horse head spelter, 35 pounds, and one pound of an alloy composed of copper, 64 pounds, silicon-copper, 25 pounds, and aluminum, 25 pounds. We greatly admire the color of the castings, which is a bright yellow, and would like to continue to use the mixture, but we find that we cannot ream the posts off freely, as the metal chokes the reamer, and produces a burr at the bottom of the post. We also experience considerable trouble in drilling the castings, as the drills become too hot. We are aware of the fact that the metal is too tough, but if we add lead it will change the color of the casting, and this we desire to avoid. Would the addition of chromium be of any benefit, in the way of making the metal machine more easily?

The addition of lead to the mixture given, ought to be perfectly feasible without greatly altering the external color of the castings. It will probably give them a more reddish cast, but this is considered more pleasing than the

pale yellow, in many cases. We suggest the addition of 3 per cent of lead to the mixture. More can be used if 3 per cent is not sufficient to confer machining properties. It would be advisable to get the mixture right in this respect first, then attend to the color afterwards. In case we are mistaken as to the effect of lead on the color of the castings, and it becomes unpleasant, a little experimenting with the deoxidizing mixture will set this right. The effect of silicon and aluminum on yellow brass is so similar, that it is difficult to detect from the color of the casting, or the appearance of the molten metal, which element has been used in the mixture, therefore it is not necessary to use the two in combination, except in the case of an alloy, requiring both high tensile strength and high elongation.

You can eliminate one of these elements, and we suggest that you first try aluminum, in the proportion of 2 ounces to the hundred pounds of brass, adding from 3 per cent upwards of lead, and if the color of the castings is not satisfactory, then try silicon. The latter element, however, cannot be used alone in any alloy containing lead, as the metal loses its sand casting qualities with a very small addition of silicon. It will be absolutely necessary to add aluminum with the silicon, but it should be in proper proportion. The correct amount of aluminum to add to 10 per cent silicon-copper to confer sand casting properties when used together with lead in an alloy is 6.25 per cent, and in case it is advisable to use silicon, an alloy should be first formed of silicon-copper and aluminum in these proportions. Chromium will in no wise assist in making the alloy free cutting, but rather the reverse.

Phosphorous Hardened Copper

Can you furnish us with a formula for making copper castings, that will take a temper and can be tempered very hard?

We are unable to furnish you with the formula desired, but suggest the use of phosphorus for hardening the copper. The phosphorus should be added in the form of 30 per cent phosphor-copper and the amount added, will be governed by the degree of hardness that it is wished to impart to the copper. The greater the amount of phosphorus, the harder the metal will be, and an example of the effect of phosphorus on copper is furnished by the 30 per cent alloy, which will be found so hard and brittle that it can be crushed quite easily.

Refractory White Metals

We would like to obtain a mixture for a white metal that can be cast in iron molds and will withstand a temperature of 1,500 *degrees, Fahr., without melting. We have tried an alloy composed of tin,* 21 *pounds; copper,* 2½ *pounds; aluminum,* 10 *pounds, and zinc,* 68 *pounds, but it would not withstand the heat requirements.*

You will be disappointed in your search for an alloy that can be cast in iron molds and will withstand the temperature given. The melting point of zinc is 786 degrees Fahr.; therefore it cannot be used, as it would volatilize at 1,500 degrees. The melting point of tin is 450 degrees Fahr., and when alloyed with zinc it lowers the melting point of that metal. Aluminum melts at 1,216 degrees Fahr., which is under the required temperature, therefore, none of these metals can be used in forming the desired alloy. Lead is also out of the question, as its melting point is 621 degrees Fahr. This eliminates all white metals with the exception of silver, nickel and manganese. The melting point of silver is 1,762 degrees Fahr., that of nickel 2,642 degrees Fahr., and that of manganese has been placed at 2,237 degrees Fahr. Any of these metals would be satisfactory as far as their melting points are concerned, but they cannot be cast in iron molds and they cannot be used alone with any measure of success for casting purposes. Silver can be eliminated on account of its cost, and nickel and manganese will have to be alloyed with copper, the melting point of which is 1,981 degrees Fahr. The only white metal that can be used in this case is German silver, and a formula that might be tried follows: Copper, 60 per cent; zinc, 21.5 per cent; nickel, 18 per cent, and manganese-copper, 0.5 per cent. A more refractory alloy is copper, 56 per cent; nickel, 39 per cent, and zinc, 5 per cent. Two ounces of aluminum should be added to both these alloys for sand castings. At a temperature of 1,500 degrees Fahr., bronze would be unsatisfactory, as it would be too soft.

Shrinkage of Copper Castings

We have a number of copper castings to make weighing about 40 pounds each, and consisting of two solid bodies joined by a thin section of less diameter. The heavy ends are about 4 inches in diameter and the trouble is caused by their shrinkage. We have tried gating at both ends, but this produced shrinkage in the middle. Can you suggest any means by which we can overcome this difficulty?

Copper is one of the most difficult metals to cast, with which the founder has to contend. In the first place it cannot be cast in a state of commercial purity like lead, tin or zinc, as it is wild when melted, and produces porous castings. Consequently, something must be added to quiet the metal, by the removal of the absorbed gases, and as various substances are used for this purpose, all of which influence the casting properties of the metal in a different way, it follows, that the same methods of molding, gating and pouring cannot be adopted with uniform success in all cases. An alloy of copper, 97 per cent, zinc 3 per cent, is much more easy to make castings from, than a metal deoxidized with silicon, especially in the case of heavy castings. The copper-zinc mixture can be handled much the same as brass or bronze, but the use of silicon as a deoxidizer, requires different methods of molding and casting, which can be applied only as a result of experience with the mixture in question. Thus for instance a flat slab of copper, that may be 3 inches wide, 1 inch thick and 18 inches long, can be cast clean and sound in the alloy of copper and zinc before mentioned by gating at one end and pouring the metal down the inclined mold. This method, however, will produce poor results with the silicon mixture, as the casting would be scruffy, and shrunken. It should be molded on edge, gated at the lower end of the inclined mold, so that the metal can flow gently up hill, and will require that a heavy feeder be taken off the highest end of the casting, in order to obtain good results. The same method can, of course, be adopted in the case of the copper-zinc alloy, with advantage, but is not absolutely necessary, and is not generally practiced, as it involves higher molding costs. The casting which is the subject of the inquiry will require to be molded in a manner suited to the particular addition that may be used with the copper. This will be assumed to be silicon, and in case the form of the casting is that of a dumbbell, it should be placed lengthwise of the mold, which when cast is inclined from one end. A heavy feeder should be connected to the highest end of the casting. The diameter of the feeder should be larger than the diameter of the casting it is intended to feed. The pouring head or sprue, is also located at the highest end of the mold, alongside the riser, and the gate should be carried by a long channel which parallels the casting to an inch or two beyond the lower end of the latter, to

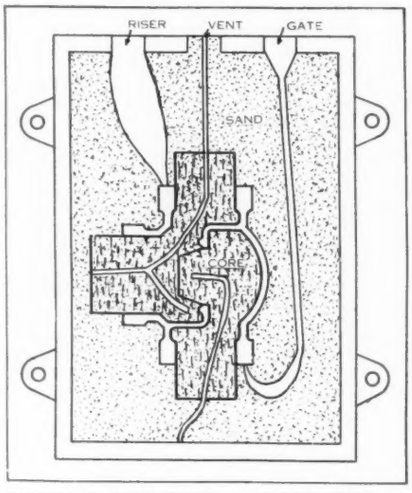
which it is joined by a semi-circular curve. In case the thin section which joins the two heavy ones, is a shell, it will not feed metal to the lower heavy part as it shrinks, and in this case two risers will be necessary, one on each of the heavy parts. The pattern should be molded crosswise of the flask, poured level, and gated with two horned gates of small diameter, and branching from a common sprue. The gates should connect with the casting at the lowest point of each of the heavy portions in the drag, so that the metal will flow into the mold from the bottom without agitation. If the shell is very thin, additional gates will need to cut thereto from the pouring sprue. In the case of the copper-zinc alloy, when the latter is poured at a certain temperature the use of heavy feeders has been found to be unnecessary, and a comparatively small sprue will produce good results with castings of thick section. This particular pouring temperature has never been determined by pyrometer, consequently it is not possible to give any idea of what it is, but it may pay to experiment occasionally to make the discovery in this particular case, as it will be found that the removal of heavy risers involves much trouble and expense.

Recent Applications of Titanium

A number of patents recently have been issued to Auguste J. Rossi, and assigned to the Titanium Alloy Mfg. Co., Niagara Falls, N. Y., covering improved methods of producing titanium and its use as a purifier of ferrous and non-ferrous metals and alloys. In the manufacture of ferro-titanium, a bath of iron is melted in an electric furnace and its surface is covered with a blanket of molten lime. A mixture of titanic acid and carbon is charged on the lime, either in a comminuted or briquetted form. The quantity of carbon must be sufficient to reduce both the titanic acid and the lime. The temperature of the furnace is then increased and the lime combines with a portion of the carbon to form calcium carbide, which acts as a reducing agent and protects the metal bath underneath. The titanium oxide is reduced at the same time by the remaining carbon, which combines with the oxygen to form carbon dioxide while the titanium is reduced to the metallic form and, sinking through the slag, alloys with the iron and forms ferro-titanium.

The addition of silicon to ferro-titanium is the subject of a separate patent recently issued. This alloy is for direct use when ferro-titanium and ferro-silicon are employed together. This permits these two elements to be added to the metal in the form of one alloy instead of two. The alloy of silico-titanium is made as follows: Fifty pounds of titanic acid; 75 pounds of carbon, and 150 pounds of silica are heated together in an electric furnace. The carbon reduces both the silica and the titanic acid to silicon and titanium, respectively, by combining with the oxygen they contain, forming carbon dioxide and an alloy of approximately 70 per cent silicon and 30 per cent titanium. By this reaction 100 pounds of the alloy is produced to which is added 20 pounds of iron forming an alloy containing iron, 16.7 per cent; silicon, 58.3 per cent, and titanium, 25 per cent.

In non-ferrous metallurgy patents have been obtained covering the use of titanium in connection with copper, zinc, tin, lead and aluminum and for use as a deoxidizer and purifier of brass,



SECTION THROUGH A MOLD FOR A LARGE VALVE THAT IS CAST UPRIGHT

bronze, aluminum and white metals and alloys. Various methods are preserved for forming the various alloys of titanium and the more fusible metals. In the case of lead, the metal is melted in a graphite crucible and lead oxide, titanic acid and shot aluminum are added. The percentage of aluminum is sufficient for the reduction of the oxides and the reaction is brought about by the application of heat, the oxygen being received from the lead and titanium oxides, and these metals are dissolved by the bath of molten lead, forming lead-titanium. All of these alloys and processes are separately covered by patents, and in the production of most of these an electric furnace is a necessary link in the process.

Aluminum-titanium is made by adding a mixture of titanium oxide and aluminum shot to a bath of molten aluminum. The latter reduces the titanium oxide with the evolution of considerable heat, which is absorbed largely in melting the solid particles of aluminum that are added together with the titanium oxide for this purpose. The electric furnace is employed in this case, not because of its intense heat, but to accurately control the temperature, as the current can be switched on or off, as desired. This alloy is used for the purification of aluminum and its alloys, and zinc-titanium, tin-titanium and lead-titanium are each, respectively, adapted for the purification of zinc, tin, or lead, although they can be used also as purifiers of copper alloys made from these various metals.

Brass Castings for Hydraulic Pressure

By A. L. Goldsmith

Castings that are required to withstand hydraulic pressure are among the most troublesome sections which the brass foundryman has to make, as the percentage of leaky castings is usually high. The source of the difficulty lies in both the metal and the molding, as the alloy must be dense and close of grain, and the casting should be properly fed and gated. After many discouraging experiences the writer finally devised a means of overcoming all difficulties, a recital of which may prove of material assistance to others similarly situated. The accompanying illustration shows how the mold for a large globe valve should be made when it is desirable to pour it upright. The gate extends to the bottom of the flask and loops into the lower flange of the casting and a heavy shrinker or feeder is taken off the upper flange as shown. In case it is thought desirable to pour flat, use a medium-size sprue for pouring and run the gate into one of the end flanges and from the opposite corner of the other flange, take off a heavy riser for feeding purposes. In ramming the mold, tuck the sand tightly around the pattern and ram very soft on top, venting thoroughly with a small vent wire. The temperature at which the metal is poured has an important bearing on the success of the casting. It should be cooled to a point where it will not bite into the skimmer when the latter is pressed down to the bottom of the crucible. The mixture, which, in an experience of 30 years has been found to give the most complete satisfaction, follows: Copper, 80 pounds; tin, 6½ pounds; zinc, 4 pounds; lead, 4 pounds, and old metal, 40 pounds. The old metal should be of good quality, either old valve metal, machinery scrap or government bronze. It must be clean and free from all contamination by aluminum.

Finishes for Nickel, Copper and Brass

By Seymour W Rowsbar

IN PREVIOUS articles we have discussed briefly the composition of nickel, copper and brass baths. The deposits obtained in the respective solutions are each of such a nature as to admit of being given a subsequent finish of great beauty. Practically every establishment doing electroplating uses one or more decorative finishes upon an electro deposit. Nickel is not affected by the ordinary oxidizing agents, and as it is very hard and exhibits but little tendency to tarnish even in the presence of moisture, it is seldom considered when artistic effects are required, silver being the popular metal for finishes necessitating a light colored base. Nickel may give a blue color resembling blued steel and popularly termed pigeon blue by using a boiling hot solution of hyposulphite of soda, 4 ounces, and sugar of lead, 4 ounces, to one gallon of water.

Dead Nickel Surfaces

Dead nickel surfaces should be colored immediately after rinsing from the plating bath to avoid stains and to produce a uniform finish. Buffed nickel surfaces must be well-cleaned. The colors obtained are yellow, purple and blue. The chemicals are cheap, the process simple and the results pleasing. The finish must be protected by lacquering to prevent fading. An oxidized effect may be produced on nickel by first buffing the deposit and then copper-plating sufficiently heavy to receive the oxide, but still allow buffing through to expose the nickel in spots, after which the copper is oxidized and lacquered with a colorless lacquer. By this method the copper edges are avoided.

Copper is one of the more easily oxidized metals and may be finished in a great variety of colors. To more thoroughly understand the action of the coloring process, we will turn our attention briefly to what takes place in the production of the colors. Unless a coloring film is sufficiently dense or opaque to entirely prevent the color of the base metal penetrating it, the natural color of the film will be affected by the color of the base. When coloring copper, the colors produced depend on the formation of oxygen and sulphur compounds. These compounds change the surface into either cuprous oxide, cupric oxide or cupric sulphide. Cuprous or red oxide of copper, Cu_2O, may exist greaty modified as regarding color, the shades obtained ranging from brilliant red to brownish black, the thickness of the film determining the particular shade of color.

Cupric oxide, Cu O, or black oxide of copper, is obtained by heat and also by the use of copper nitrate. A film of oxide may consist of both cuprous oxide and cupric oxide, the first mentioned being in contact with the copper base. The cupric sulphide, Cu S, is formed by the use of sulphur in one form or another and produces the darkest of oxides obtained on copper.

Green Copper Finishes

Of all the decorative finishes produced on a copper surface, the beautiful green shades obtained by the action of chemicals and the moisture of the air are without exception the most pleasing. As we will treat on verde antiques and patinas in a subsequent paper, a brief reference only will be made here. A solution which gives excellent results is composed of sal-ammoniac, 1 pound; sulphate of copper, 1 pound; sea salt, 1 pound; sulphate of zinc, 2 ounces, and acetic acid, 12 ounces. Dissolve the chemicals in 5 gallons of boiling water, clean the articles and slightly oxidize in liver of sulphur dip; then rinse and immerse in the hot solution. If the color is heavy, dilute the solution somewhat until the color is satisfactory. The immersion may be repeated after allowing the article to dry without rinsing. After the final dip and before the color is too dry, variegated tones may be produced by stippling with a sash brush moistened with the solution. When finished, apply transparent lacquer, to which has previously been added a little aniline green dissolved in methylated spirits. This imparts a greenish hue to the lacquer. The article may then be waxed if desired, by using beeswax or paraffine wax on a very soft brush. Beeswax gives best results. The wax may also be given a shade of green by either coloring the wax in a melted condition or by applying the dry green coloring dye to the wax on the brush.

Royal Copper Finish

Another novelty finish which is very popular is the royal copper. The simple method of dipping the coppered articles in melted nitre is, however, not the best. To obtain the full beauty of the royal copper finish proceed as follows: Deposit a film of lead upon the copper; the lead bath being composed of litharge, 6 ounces; caustic potash, 6 ounces, and water, 1 gallon. Boil for one-half hour, allowing it to settle, after which pour off the clear liquor and use this as the solution. After obtaining the lead film on the copper, the article is heated to a low red color by means of a blow pipe. A black coating is formed by this operation. Next, by removing this superficial oxide with a soft buff and coloring rouge, the royal copper is

exposed in all its regal beauty. For all ordinary oxidizing purposes the liver of sulphur solution is generally used. Every plater is acquainted with this dip, but there are many who have not used the barium sulphide solution and to these we would suggest that it be given a trial. It is prepared and used in the same manner as the sulphurette solution. For certain lines the barium sulphide is especially adapted and is largely used on hardware and chandelier work.

An arsenic oxidizing solution should be kept in readiness when ornamental finishes are required on short notice. By its use brass may be given a blue-black color and the film, when relieved, presents the effect of antique brass. The solution should be used warm for rapid work and is composed of white arsenic, 15 ounces; sulphate of iron, 1¾ ounces, and hydrochloric acid, 1 gallon.

Gold Color on Sheet Brass

To produce a pleasing green or a golden color on sheet brass novelties at small expense, the following method may be employed: Dissolve 1¾ ounces of caustic soda and 1½ ounces of milk sugar in 1¾ pints of water and boil for 15 minutes. The solution, which is clear at first, soon acquires a dark yellow color. Remove the solution from the heating apparatus and stir-in 1½ ounces of saturated solution of copper sulphate. Suboxide of copper is formed as a red precipitate; this soon settles. When the temperature of the solution is reduced to about 170 degrees Fahr. it is ready to use. The articles are placed on a perforated wooden disc or sieve and are immersed in the solution. The golden color is usually quite pronounced in about two minutes. A longer immersion produces a fine green luster. The colors should be produced slowly if desired uniform and the solution should be kept air tight if it is required for future use. It may be invigorated when nearly exhausted by replacing the water lost by evaporation and adding ½ ounce of caustic soda, boiling for a few minutes and then adding an ounce of copper sulphate solution as mentioned previously.

Hardware green on brass may be produced by either of the following formulas, both being used extensively: Dissolve 1 ounce of nitrate of iron and 8 ounces of hyposulphite of soda in one gallon of water. Use at boiling point; or dissolve 8 ounces of double nickel salts and 8 ounces of hyposulphite of soda in one gallon of water and use hot. The operator should bear in mind that the color obtained on the surface of an article oxidized will depend on the strength of the solution to effect a chemical reaction and to produce a colored compound of the metal with such elements as sulphur chlorine or oxygen. The resulting color will depend somewhat upon the cleanliness and mechanical finish given the surface previous to oxidizing. A cleaning preparation now on the market is especially adapted for preparing metallic surfaces for coloring as it does not in any way affect the most brilliant luster which may be imparted mechanically, yet cleanses the surface pores and leaves a chemically-clean surface free from clouds or stains, even though the work be left in the solution for an unreasonable period. Soldered joints are not affected as in ordinary cleaning solutions.

TROUBLES OF THE ELECTRO-PLATER

Discussed by Practical Men

Flemish Brass Finish

We desire information concerning the Flemish brass finish, and would like to know how it is obtained.

Flemish brass is a finish used extensively on chandeliers and interior hardware. It is quite easily obtained and makes an excellent match as a metal finish when used on Flemish oak trimmings. The process follows: The brass is first given a scratch-brush finish, usually by the use of tampico, which is used wet and a mixture of pumice and ground flint; or, a sand blast will produce a good surface. The brass is then cleaned and dipped into a hot solution of the following composition: White arsenic, 1 ounce; muriatic acid, 1 quart, and water, 8 to 10 gallons. A small piece of potassium sulphurette is dissolved in the solution just before using. This addition causes the liberation of hydrogen gas and thus darkens the arsenic deposit. The color is too bright unless this is done. The solution requires frequent additions of sulphurette and an occasional addition of arsenic to produce uniform results. The temperature of the solution should be about 150 degrees Fahr. Stir the solution well before using. The brass is allowed to remain in the solution until the desired shade is obtained and is then removed and rinsed. After drying, it is given a coat of lacquer, various effects and tones being produced by using laquers of different colors.

Silvering Formula

We would like to have a good glass silvering formula.

The following formula will prove reliable and not difficult to use:

(a) Reducing solution:—Dissolve 12 grains of rochelle salts in 12 ounces of boiling water. While boiling, add 16 grains of nitrate of silver, dissolved in one ounce of water, and boil for 10 minutes. Then add sufficient water to make up the loss from evaporation.

(b) Silvering solution:—Dissolve 1 ounce of nitrate of silver in 10 ounces of water and add liquid ammonia until the brown precipitate is nearly, but not quite dissolved. Add 1 ounce of grain alcohol and sufficient water to make 12 ounces.

To silver, take equal parts of (a) and (b), mix them and lay the glass face down in the mixture; the glass previously should be cleaned with potash or washing soda and should be well rinsed in water. The vessel containing the silvering mixture should not be much larger than the glass. Another method that can be followed satisfactorily is to clean the glass thoroughly and to arrange a dam of wax or other material around the edge to hold the solution. Flow the solution over the surface and allow it to stand. The silver will deposit on the glass in from one-half to one hour.

Open-Hearth Furnace of a Detachable Type

Steel and High Grade Iron for Castings is Poured Direct From the Melting Chamber into the Molds---Stacked Castings

OPEN-HEARTH furnaces of the standard type, of as small capacity as only 15 tons per heat, are not adapted to the requirements of the average foundry engaging in steel casting work. It is well known that an open-hearth unit cannot be operated economically except on a continuous basis, as the repeated heating and cooling of the lining and roof, when only one heat per day is made, results in a large increase in the cost of repairs. On the other hand, if the furnace continues to be heated after the day's melt to maintain it in readiness for the next day's operations, the cost of fuel becomes excessive and the expense of producing the castings is increased proportionately thereby. Many foundrymen operating gray iron shops have installed steel departments to meet the demands of their trade and the average steel casting output of such plants rarely exceeds a few tons a day. As the standard type of open-hearth furnace is not adaptable to these requirements, converters have been added to the equipment of these shops, and during the past few years a large number of such installations have been made. The converter can be operated economically in the production of small heats of steel and possesses many advantages for the foundry having a limited output as compared with the smallest size standard open-hearth.

W. M. Carr, author of *Open-Hearth Steel Castings,* for more than five years has been engaged in the development of a small open-hearth furnace in which heats varying from 2,000 to 4,000 pounds could be made and which would be adapted to the needs of the steel foundry of limited output. Nearly three years ago he built a fuel oil open-hearth furnace of small capacity which was exceedingly original in design. The melting chamber was cylindrical in form and was entirely separable from the ports. To avoid the trouble with slag when lip-pouring, the furnace was fitted with a nozzle and stopper operated through the charging door, which was set in place long enough before tapping to permit of heating the stopper fittings. The furnace was so constructed that it could be carried to the molds and could be used as a combined melting medium and pouring ladle.

During the past few years this type of furnace has been developed further and is now on a practical commercial operating basis. Three of these small open-hearth furnaces have been installed in the plant of the Alloy Steel Casting Co., Glenova, Wheeling, W. Va., of which Mr. Carr is general manager. The three furnaces in this plant, two of which are shown in Fig. 1, are of one and two tons capacity, as against 500 pounds per heat, the capacity of the original, experimental furnace. Castings varying in weight from one ounce to several thousand pounds are being made for the automobile and general machinery trades. The parts are being cast of both standard and alloyed open-hearth metals

This type of furnace is designed and constructed on the principle of securing on a small scale all of the advantages of the standard open-hearth furnace of larger capacity. It is well known that a small volume of steel produced by the open-hearth process involves some risk in chilling, thereby causing some misruns of light, thin sections. This would occur if a ladle were used to transfer the metal from the furnace to the molds. The use of a ladle, therefore, has been dispensed with and the metal is poured direct from the melting chamber into the molds. At tapping time, the melting chamber is lifted away from its ports by a crane and is conveyed to the pouring floor. The

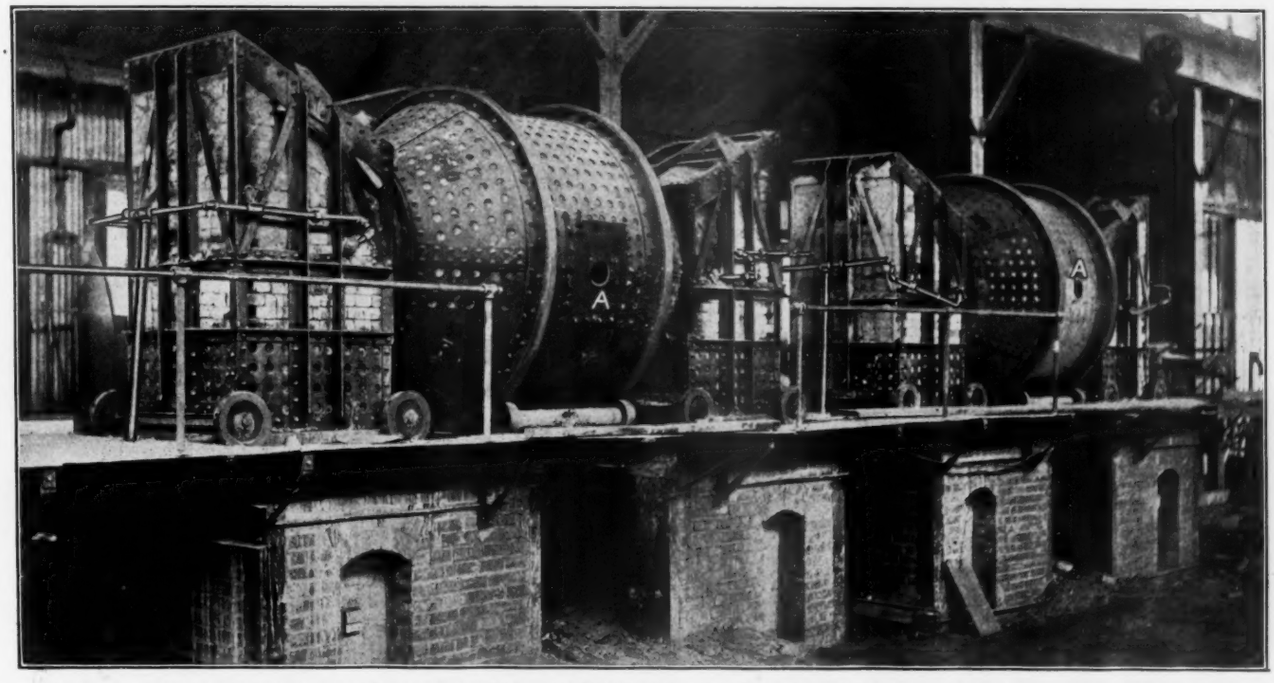


FIG. 1—THE CARR DETACHABLE OPEN-HEARTH FURNACES IN THE PLANT OF THE ALLOY STEEL CASTING CO.

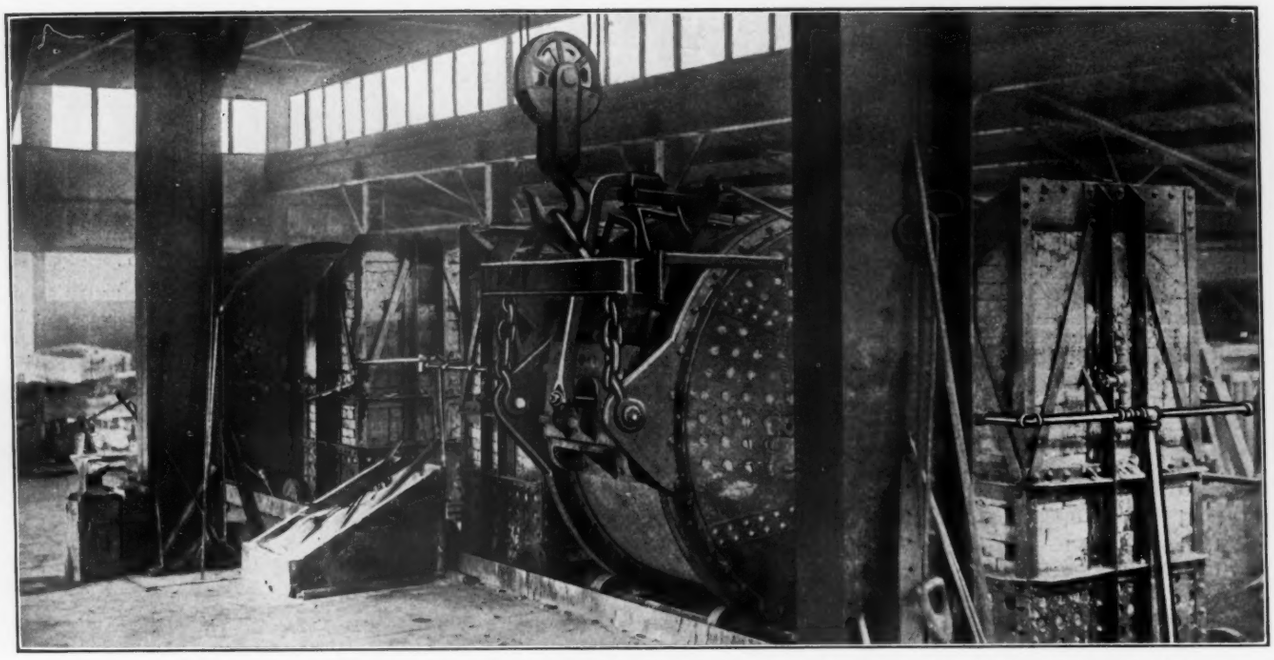


FIG. 2—PREPARING TO LIFT AWAY AND ROLL-OVER THE MELTING CHAMBER FOR POURING THE MOLDS

flow of the metal is controlled by a nozzle and stopper fittings fixed in position shortly before pouring. By this method the initial temperature of the metal is preserved and small castings can be poured which heretofore have been considered impossible to cast by the ordinary open-hearth process.

The metal produced is exceedingly uniform in quality and for this reason and due to the high casting temperature, the furnace can be employed for making tool steels of crucible compositions. As the volume of steel is small, the ferro-alloy additions can be distributed uniformly throughout the entire bath of metal. The melting chamber being detachable, practically no time is lost in making repairs or relining, spare lined shells being kept on hand for immediate substitution. The time thus saved is a distinct advantage over the standard type of open-hearth furnace which must remain in idleness throughout the entire period of general repairs. In addition, the cylindrical construction of the melting chamber and its comparatively small size permits of obtaining a hotter metal than that procurable by the ordinary open-hearth process, which is at a temperature of approximately 1,500 degrees Cent. when tapped into the ladle. In this furnace, the temperature of the steel, obtained by pyrometer measurements, is 1,600 degrees Cent. at pouring

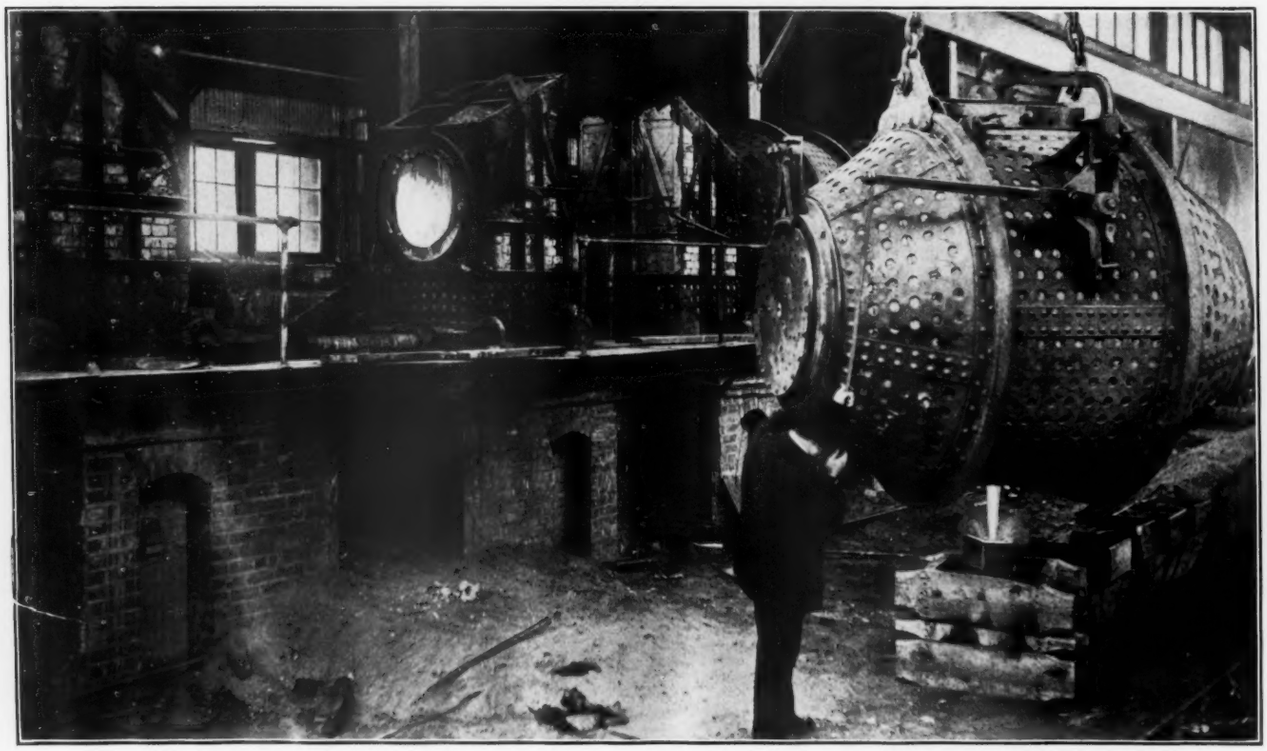


FIG. 3—THE MELTING CHAMBER USED AS A LADLE AND IN POSITION POURING A MOLD

FIG. 4—A GENERAL VIEW OF THE ALLOY STEEL CASTING CO.'S FOUNDRY, SHOWING THE MELTING CHAMBER EMPLOYED AS A LADLE AT THE EXTREME END OF THE POURING FLOOR

time and is practically at this temperature when entering the molds, there being no loss of heat as would be the case if the steel were first poured into a ladle.

These furnaces also are employed for melting iron and the metal is exceedingly close-grained, tough and possesses wonderful malleable properties. This product is termed Carr's vanadium iron, and its process of manufacture will be described later in this article. Plan, rear and side elevations of one of these small furnaces is illustrated in Fig. 16. Two regenerative chambers are provided similar in design to those employed for an open-hearth unit of larger size. The burner ports are mounted on wheels and operate on a track, being set directly over the regenerators when the furnace is in operation. Fig. 1 shows two of the furnaces in melting position, the tap holes being indicated at *A*. It also will be noted that the melting chambers are mounted on rollers to permit of rolling-over the furnace when the crane picks it up to convey it to the pouring floor. In Fig. 1 the four regenerative chambers, two for each furnace, are clearly illustrated. As natural gas is available in abundance in the Wheeling district, it is used for fuel, although fuel oil also can be employed. The burners enter

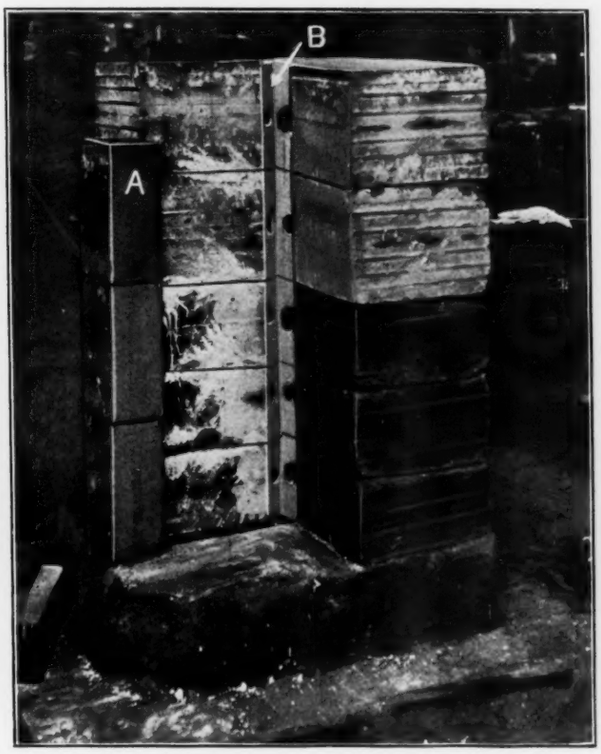


FIG. 5—METHOD OF STACKING SNAP FLASK MOLDS

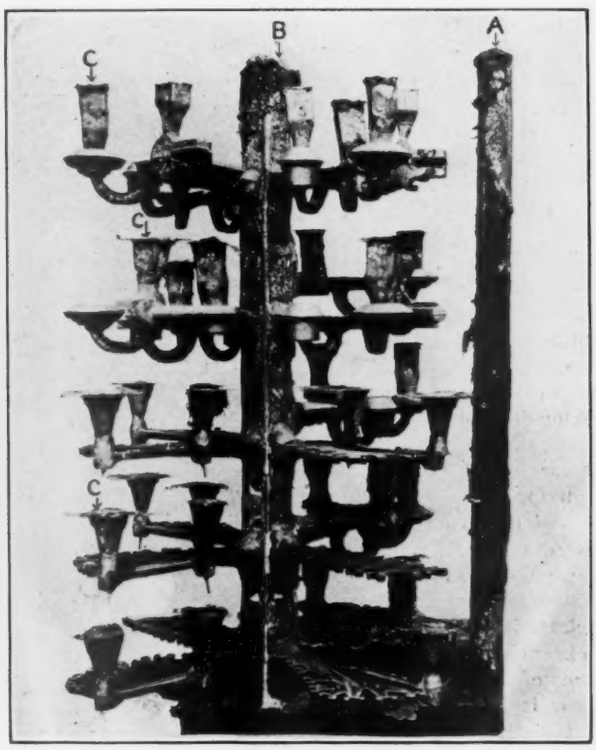


FIG. 6—A STACK CONTAINING 121 STEEL CASTINGS

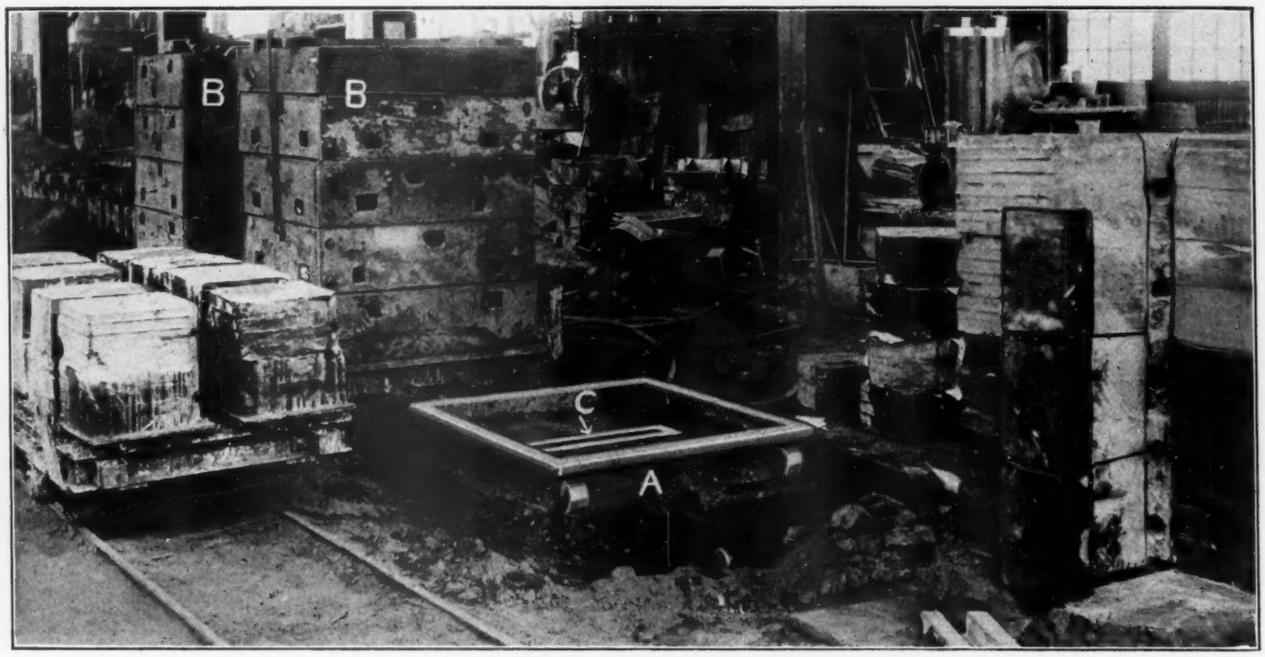


FIG. 7—TWO OF THE STACKS READY FOR POURING ARE SHOWN AT *B*

the ports from the front and back and the burning gas is deflected by a bridge wall in the burner port into the melting chamber. The inclined roof of the burner port also serves to deflect the gas onto the metal bath. The ports are lined with silica brick and are of self-contained construction, the framework being rigidly built of steel angles and plates.

The Melting Chamber

The melting chamber is cylindrical with truncated cones at either end which connect with the openings in the burner ports. The shell is made of steel plates, the cover being riveted to the cylindrical section of the shell. The perforations in the shell serve to reduce not only the weight of the furnace, but also radiate the heat from the lining, keeping it cool on the outside and lengthening its life. The furnace is practically without a roof, although that section of the lining above the metal bath is so indicated. No bricks are used for lining, but instead a gannister lining is rammed in position inside of the shell of the body and cones. Three forms are employed for making the body lining and four for each of the cones. This continuous lining is preferred to brick, remaining in position when the melting chamber is rolled over for pouring and the cost of repairs is small as compared with the expense of a brick lining in a furnace of this type. The melting chamber is 7 feet long and the main body is 3 feet, 6 inches in diameter inside of the lining. When lining a shell a man enters the chamber through the charging door through which the forms also are passed, and rams the gannister between the forms and the shell. Either an acid or basic lining can be employed, although these furnaces are lined for the production of acid steel. By maintaining a number of spare, lined shells, the change from acid to basic, and vice versa, can be made by merely substituting an acid or basic lined shell for the one in position. The operation merely consists of lifting out the melting chamber by a crane and replacing it with the one required, lined for the class of steel to be made.

The increase in temperature of practically 100 degrees Cent. in a cylindrical furnace of this type, over that obtainable in an ordinary open-hearth furnace is due to the fact that the radiating effect per square inch of heating surface is greater than in a rectangular furnace of large size. As the intensity of radiation varies inversely with the square of the distance, it becomes evident that there are heavy losses in the radiated heat from the sides and corners of a rectangular furnace where the sides

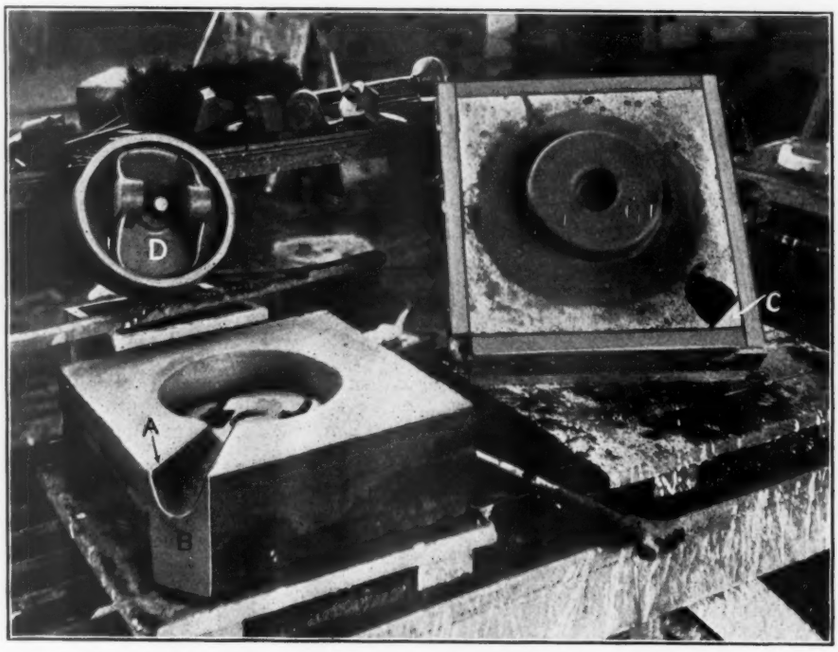


FIG. 8—DRAG AND COPE OF SNAP FLASK MOLD, SHOWING CORNER GATE AT *A*

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form

FORMULAS FOR THE BRASS FOUNDRYMAN

Brazing Solders

Ordinary brazing or hard solder is an alloy consisting of equal parts of copper and zinc. For special purposes the proportions of the two metals may vary within wide limits, according to the purpose for which they are intended. The fusing point of the solder must be below that of the article soldered. The higher the percentage of copper, the stronger and the more refractory the solder will be. To lower the fusing point, tin and lead are frequently added to the alloy. A number of typical formulas are given in the following table:

COPPER, POUNDS.	ZINC, POUNDS.	TIN, POUNDS.	LEAD, POUNDS.
58	42	..	..
54	45	1	..
53	47	..	..
50	50	..	..
45	50	3½	1½
34	66	..	..
44	50	4	2
57	28	15	..
48	48	4	..

Spelter Solder

Spelter solder also is, frequently, made by the addition of zinc to sheet brass. A number of these solder mixtures follow:

SHEET BRASS CLIPPINGS, POUNDS.	ZINC, POUNDS.	TIN, POUNDS.
75	25	..
64	36	..
70	24	6
67	30	3

Borax is generally used as a flux with spelter solder, being reduced to a paste with water. Boric acid mixed with carbonate of soda also is used.

USEFUL INFORMATION FOR THE FOUNDRYMAN

Strength of Crane Chains

DIAMETER OF LINK, INCHES.	ULTIMATE STRENGTH OF CHAIN IN POUNDS PER SQUARE INCH.	SAFE WORKING LOAD IN POUNDS.
¼	3,360	840
5/16	5,040	1,260
⅜	7,280	1,820
7/16	10,080	2,520
½	13,440	3,360
5/8	20,720	5,180
1	53,760	13,440
1¼	84,000	21,000
1½	120,960	30,240

In the above table the safe working load is given with 4 as a factor of safety. In some cases a factor of safety of 6 is used, and can be obtained by dividing the ultimate strength by 6. Chains should be frequently examined, and occasionally annealed to prevent crystallization. As the links wear, the strength of the chain is correspondingly reduced.

The Strength of Manila Rope

Manila rope is measured by circumference instead of diameter, therefore, a 3-inch rope is nearly 1 inch in diameter. The strength depends upon the quality of the fibre, and the solidity with which the rope is twisted. A 3-inch rope, soft laid, has a maximum strength of about 7,300 pounds, while a hard laid rope will withstand up to 9,000 pounds. The breaking strength of ropes can be obtained approximately by multiplying the square of the circumference by 8 and the product by 100, which gives the strength in pounds. For blocks and falls, the rope should be figured at one-eighth its breaking strength, using two double blocks of suitable size. Thus, if 1,000 pounds is to be raised regularly, two double 8-inch blocks, equipped with 3-inch manila rope, should be used. For direct pulls on single ropes, the latter should be operated at only one-twentieth of its breaking strength, to allow for wear and tear.

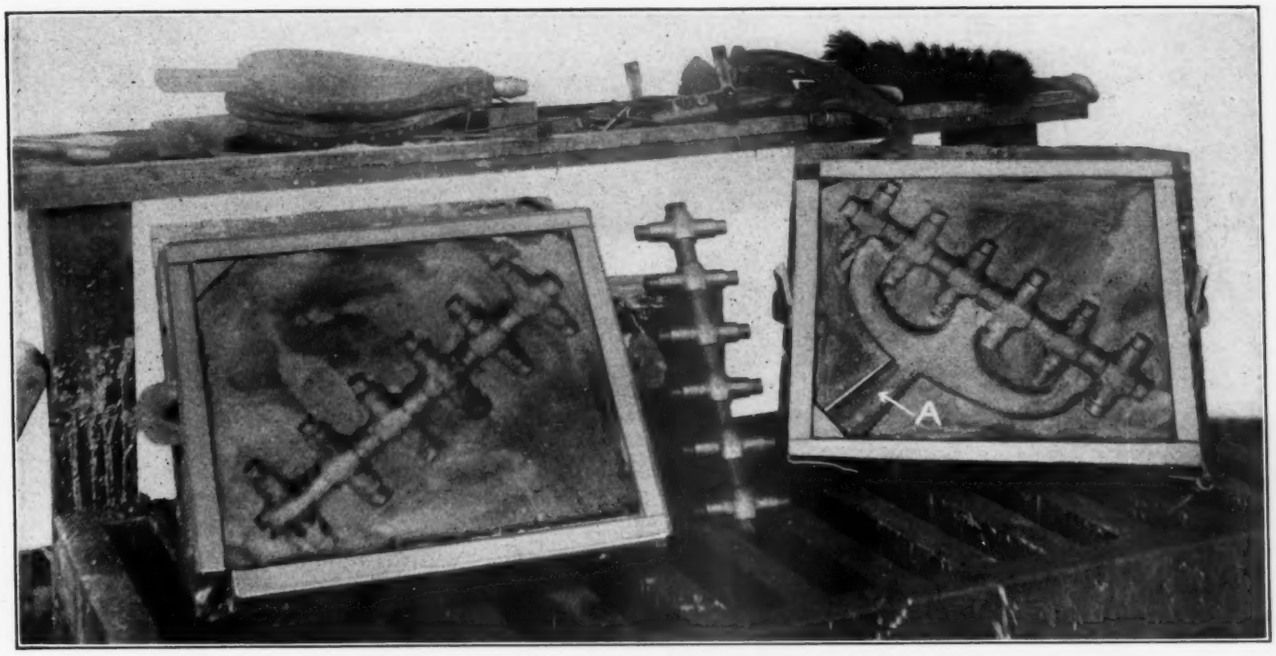


FIG. 9—COPE AND DRAG OF MOLD, SHOWING ARRANGEMENT OF CORNER SPRUE AND GATE

join the roof. This loss in radiation occurs at a point in each side of the furnace where the circumference of a circle, struck with a radius from the center of the bath, contacts with the sides and the loss in radiated heat increases toward the top of the furnace, being greatest at the points where the sides join the roof. On the other hand, no such losses in radiation can occur in a cylindrical furnace, and consequently, the entire effect of the radiated heat is obtained, thereby reducing the melting period to only 3½ hours as compared with 7½ to 12 hours required in large open-hearth furnaces of the rectangular type. This results, furthermore, in an increased temperature of the metal at the pouring period. The depth of the bath in the cylindrical furnace, in proportion to the area of the surface of the metal, is much greater than that of a large, rectangular furnace in which the bath of metal is spread over a large area. A deep bath in open-hearth steel operations is the ideal condition sought, as it hastens the refining reactions and aids in reducing the time required for making a heat. Only a small percentage of ore is employed and the reactions are not hastened so as to give the oxides an opportunity of burning out. This results in an exceedingly homogeneous product free from blow-holes and the losses resulting from occluded gases are unusually small when compared with ordinary steel foundry operations.

FIG. 10—SAMPLES OF LIGHT STEEL CASTINGS

High Phosphorus Steel

A peculiarity of the steel made in these furnaces is the fact that a high phosphorus content does not affect the quality of the product. The percentage of phosphorus in the castings ordinarily made runs as high as 0.09 and their physical properties are practically the same as those of other grades of acid steel. The metal is exceptionally tough and can be bent flat when cold without fracture. The analyses of the acid steel castings now regularly made from metal refined in these cylindrical furnaces, range as follows: Carbon, 0.25 to 0.30 per cent; silicon, 0.30 to 0.40 per cent; phosphorus, 0.04 to 0.09 per cent; sulphur, 0.03 to 0.04 per cent, and manganese, 0.5 to 0.7 per cent.

Short Pouring Period

As the pouring interval of a furnace rarely exceeds 15 minutes, the quality of the steel at the end of the pour is practically the same as at the beginning. One of the difficulties experienced with large open-hearth units in steel foundry practice is the difference in the quality of the metal at the beginning and the end of the pouring interval. The qual-

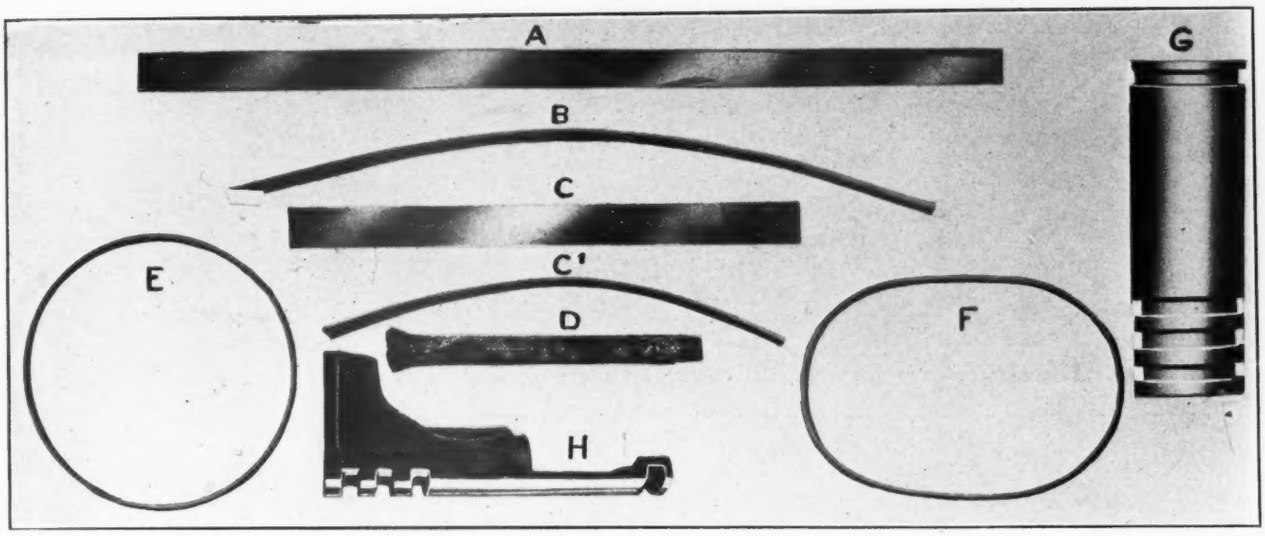


FIG. 11—SAMPLES OF CARR'S VANADIUM IRON CASTINGS

ity of the metal last tapped from the furnace, is usually inferior to that tapped into the first ladle, and, although various expedients have been sought to overcome this difficulty, it persists in many plants and is the cause of heavy losses. At the beginning and the end of the pouring interval there is practically no change in the quality of the steel poured from one of these small open-hearths. The following analyses are of steel, made in a detachable furnace, from the beginning and end of a pouring interval, and the variations in the content of the various elements are so hlight that they might be attributed to ordinary errors in making the determinations:

	Beginning of pour, per cent.	End of pour, per cent.
Carbon	0.33	0.33
Silicon	0.50	0.46
Sulphur	0.04	0.041
Phosphorus	0.04	0.038
Manganese	0.42	0.49

As the pouring period, owing to the small volume of steel, is practically one-half of that of a large furnace, the steel does not have time to segregate and remains uniform in quality.

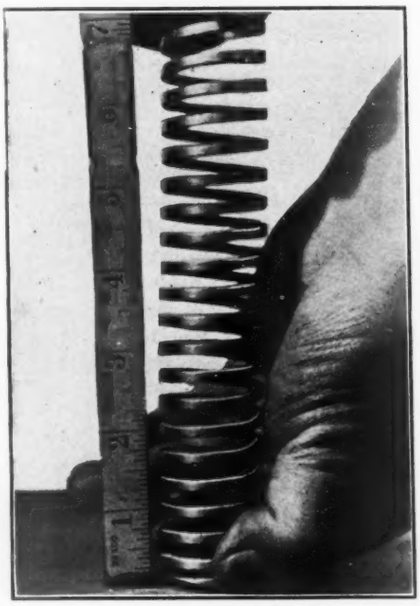


FIG. 12—CAST IRON SPIRAL SPRING EXTENDED

For making certain castings, copper is alloyed with the steel in proportions as high as 0.5 per cent. The copper is thrown into the furnace in ingot form with the charges and it has been found that it greatly increases the toughness of the metal. Castings made from copper steel can be hammered without fracture and are unusually free from blow-holes.

As previously stated, when melting, the furnaces are in the position shown in Fig. 1. In Fig. 2 the crane supporting a bail on the crane hook is in position for lifting the melting chamber away from the burner ports ready for pouring. The stopper has been fixed in position and in the tapping hole, *A*, Fig. 1, the nozzle has been inserted. If, after rolling-over the melting chamber slightly, a leak occurs at the nozzle, the furnace is rolled back into melting position and repairs are made. The furnace is attached to the chains on the

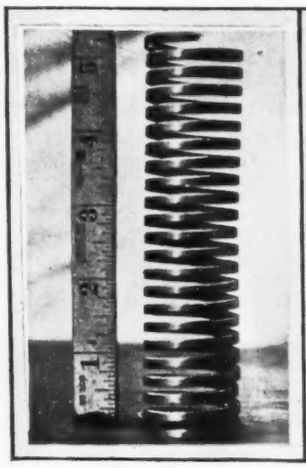


FIG. 13—CAST IRON SPIRAL SPRING

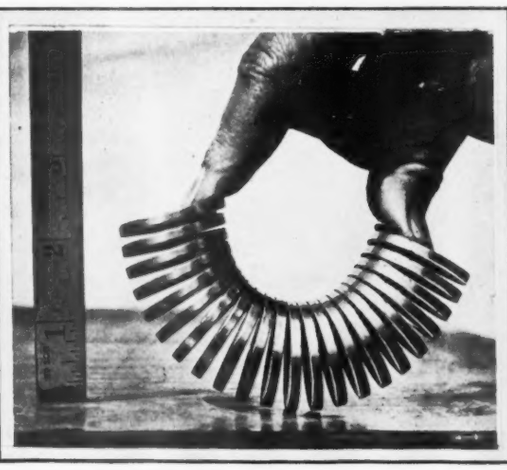


FIG. 14—BENDING TEST OF CAST SPRING

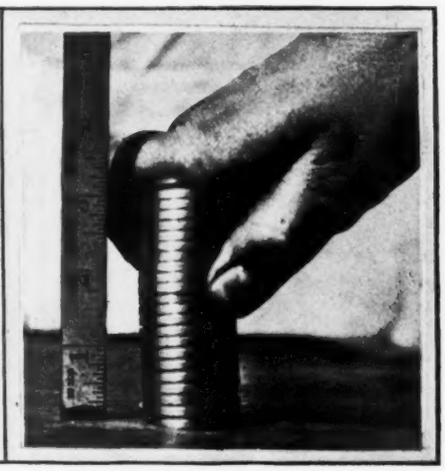


FIG. 15—SPIRAL SPRING COMPRESSED

bail by links which pass over lugs riveted to the shell on either side of the charging door. These links are held in position by pins passing through the lugs, the pins being locked to prevent shifting. In the meantime the burner ports have been moved back on the track and covers are adjusted over both ends of the cone openings of the melting chamber where they connect with the burner ports. Fig. 3 shows the melting chamber suspended by the crane, rolled-over and in pouring position. The stopper is controlled by a lever at the side of the shell. Fig. 4 is another pouring view, showing the melting chamber employed as a ladle at one end of the foundry floor. After the steel has been poured, the slag is permitted to run out and the furnace bottom is left unusually clean. The melting chamber is then returned to the furnace platform, rolled-over into melting position, the stopper and covers are removed and the burner ports are moved back into position. After fixing the bottom, the furnace is ready for the next heat.

The high pouring temperature of the metal permits of casting exceedingly thin and light sections. The gate containing the five letters, abbreviating the firm name, in Fig. 10, is an example of the light work that can be successfully cast without risk of mis-runs. The letters are approximately ⅛ inch thick. A steel key also is shown and at the left is a cast steel bar which was bent almost flat without fracture. The two castings at the right weigh slightly less than one ounce each and are being cast regularly by the Alloy Steel Casting Co.

Practically all light snap flask work is stacked to facilitate pouring. The method of building-up one of these stacks is illustrated in Fig. 5. Four of the molds are bedded in a jacket or flask and the stack is poured five-high. To more clearly show how the stack is built, one height of flasks has been omitted from the stack in Fig. 5. The metal enters the stack from the bottom through a runner, *A*, built-up to the top of the stack and which connects with a bottom runner through which the metal flows and enters the common sprue, *B*, extending through the center of the stack. The metal enters the molds through corner sprues connecting with the gates. The center sprue is made by cutting off diagonally the corner of each flask in which the sprue is located, and this is accomplished by stopping-off this corner in the snap flask when making the mold. The large center sprue, therefore, is square and is of sufficient size to feed all of the molds. Risers also are arranged in each mold and are clearly shown in Fig. 6. This cast steel stack contains 121 castings, the maximum weight being 15 pounds and the minimum, ½ ounce. This remarkable result is obtainable only with exceedingly hot metal and is novel practice as applied to steel foundry operations. In Fig. 6 the runner is shown at *A* and the square center sprue, at *B*. A few of the many risers are indicated by *C*. The loss consisting of runner, sprues, gates, and risers varies from 45 to 60 per cent, which is no greater than when the molds are cast separately. The

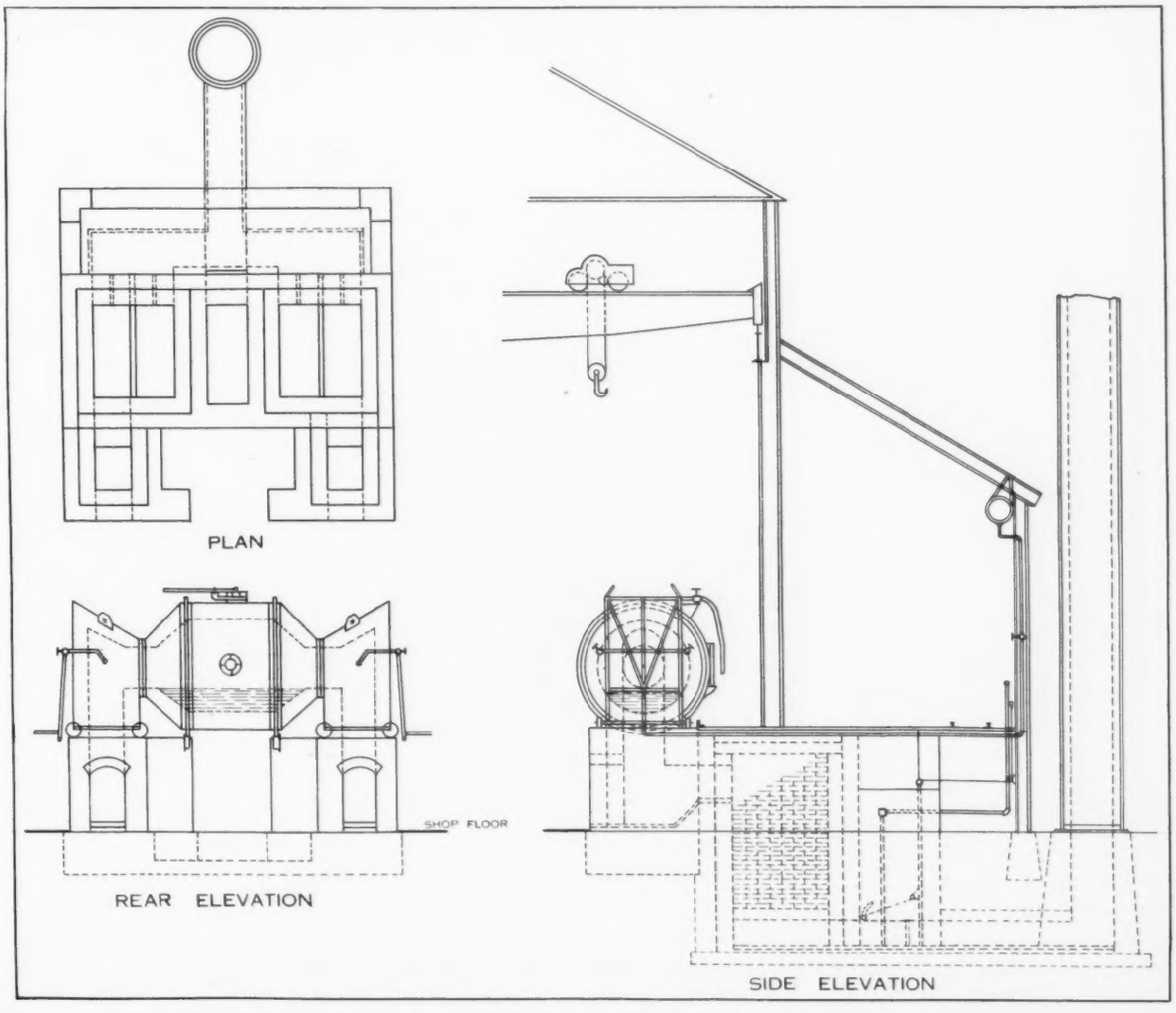


FIG. 16—PLAN, REAR AND SIDE ELEVATIONS OF DETACHABLE OPEN-HEARTH FURNACE

pouring period of casting this stack was only a fraction of the time that would be consumed in casting the 20 separate molds. The bottom or runner section of one of these stacks is illustrated at *A*, Fig. 7. Two of the stacks with the pouring basin in position ready for the metal are shown at *B*. The dry sand molds are bedded inside of the jacket, which also contain the runner. The bottom runner connecting with the center sprue is shown at *C*. At the right is illustrated a section of the stack, Fig. 5. This clearly shows the sprues of five of the molds.

In Figs. 8 and 9 the method of making these snap flask molds is clearly shown. The corner gate is at *A*, Fig. 8, and one corner of the mold is diagonally cut off at *B*. The stop-off in the cope flask is shown at *C*. A similar stop-off is located in the drag flask. The pattern for this mold is at *D*. Another mold made with a gate to which six patterns are attached is shown in Fig. 9. The sprue, *A*, leads to one corner of the mold which is cut off diagonally to form the large center sprue.

Vanadium Iron

Gray iron melted in these small open-hearth furnaces develops wonderful physical properties. It is not only tough, close-grained and machinable, but is exceedingly malleable and can be highly polished. At *A* and *C*, Fig. 11, are shown two cast iron strips, about ⅜ inch thick, made from Carr's vanadium iron; *B* shows to what extent strip *A*, could be bent without breaking, and *C*¹ is strip *C* bent to show its elasticity. Strip *C* was made from a softer mixture than *A* and proved more elastic; *E* is a round chip cut from a piston ring casting and *F* shows to what extent this chip can be distorted without breaking; *G* is a section of a vanadium iron gas engine piston and shows the high polish that can be obtained on this metal, and *H* is a sectional view of a part of this piston casting.

A cast iron spiral spring made of this metal and which reflects its wonderful elasticity, is illustrated in Figs. 12, 13, 14 and 15. The spring can be expanded, compressed and bent through an angle of nearly 180 degrees, without breaking. The spring, which is about 5⅜ inches long, is shown in Fig. 13. The spring is expanded to a length of 7¼ inches in Fig. 12 and in Fig. 15 has been compressed to 3¼ inches. The bending test is shown in Fig. 14.

The control of the mixtures in this type of open-hearth furnace, when melting iron, is practically perfect. Recently, on a certain grade of piston iron, the specified silicon content was 1.6 per cent and the silicon in the castings was 1.55 per cent. The percentages of other elements in this piston iron follow: Sulphur, 0.029; phosphorus, 0.20, and manganese, 0.48. A cylinder iron which was specified to contain 2.25 per cent silicon in the casting contained 2.39 per cent and the percentage of the other elements in this cylinder mixture are given herewith: Sulphur, 0.027; phosphorus, 0.19, and manganese, 0.56. These actual silicon analyses show how closely the specified content can be approximated. Both mixtures contained a small percentage of vanadium.

The mixtures consist of 50 per cent of pig iron and 50 per cent of return iron scrap, no steel being employed. The metal is poled with green timber and approximately 1½ hours is required to make a heat. Natural gas is used for fuel and the sulphur can, therefore, be maintained at a low percentage. The metal is poured from the furnace into a tea-pot ladle equipped with a bottom-pour spout. By the use of this type of ladle, dirt and slag on the iron is prevented from entering the molds. This iron, in its physical properties, closely resembles steel. These extraordinary properties are imparted to this cast iron by the employment of special fluxes and by the method of melting. The fuel used also is a factor as well as the unusual design of the furnace utilized for melting this metal.

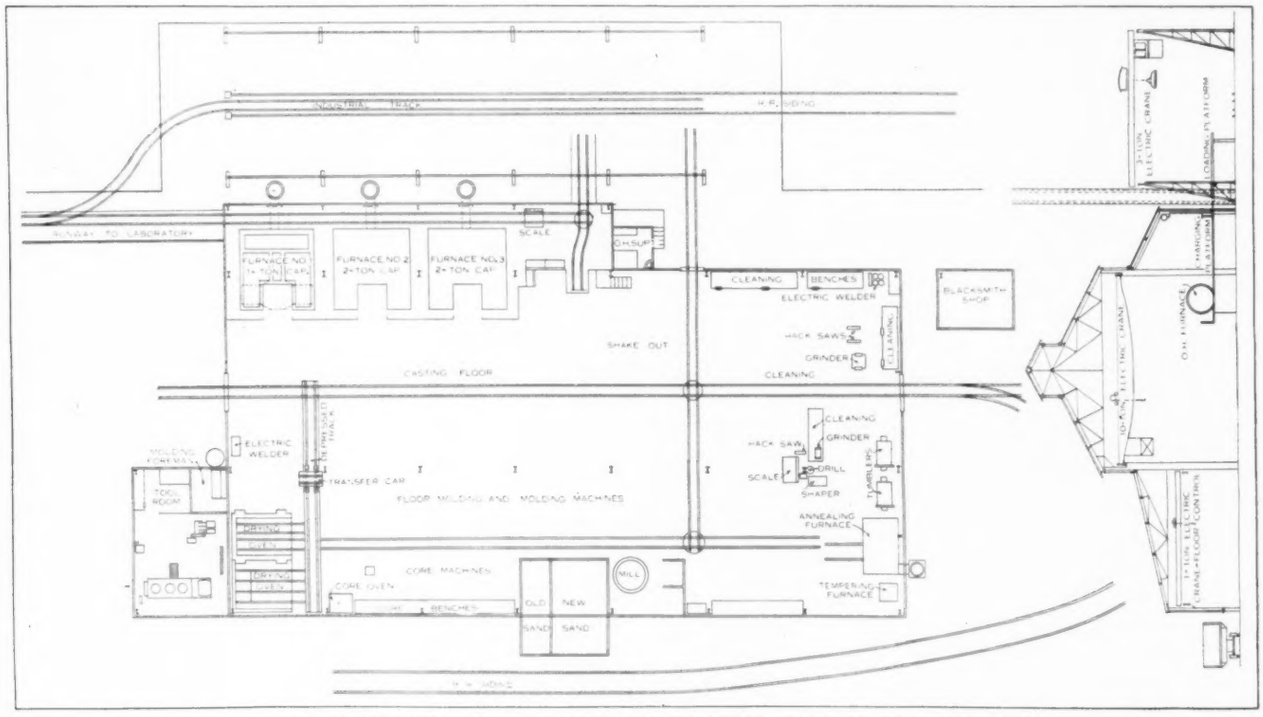


FIG. 17—GROUND PLAN OF THE ALLOY STEEL CASTING CO.'S FOUNDRY

Alloy Steel Casting Co.'s Foundry

The Alloy Steel Casting Co., whose plant is located at Glenova, a suburb of Wheeling, operates under a license from the Carr Furnace Co., which owns the patents of the detachable open-hearth furnace. This iron and steel casting plant is a model foundry and is modernly-equipped throughout. The main building is 80 x 140 feet, of steel construction and is divided into three bays. As shown in the ground plan,

Fig. 17, the furnace bay adjoins the metal storage yard, and the furnace platform extends into the middle bay a sufficient distance to permit the 10-ton crane, which commands the center of the shop, to handle the melting chambers of the furnaces. In the opposite side bay are located the snap flask molding and coremaking departments. The middle bay is devoted to large floor work, pouring, shaking-out and cleaning. The molding machine equipment consists of two jar-rammers, one for molds and the other for cores, installed by the Osborn Mfg. Co., Cleveland, as well as a number of squeezers. The melting equipment consists of two 2-ton detachable open-hearth furnaces and one 1-ton furnace of the same type. For drying the molds two ovens have been provided. From the ovens the molds are conveyed to the pouring floor on a transfer car operating over a depressed track. In the opposite end of this bay are located the annealing and tempering furnaces, tumbling mills, shaper, hack saw and grinder. This bay is commanded by a 1-ton crane.

The metal storage yard is commanded by a 3-ton crane equipped with a lifting magnet for handling pig iron and scrap. The furnace charges are made-up in the yard and are piled on buggies operating on an industrial track which connects with the track on the charging platform. The entire crane equipment, including a one-ton electric traveler in the middle bay, was installed by the Northern Engineering Co., Detroit. The shop is well-lighted by two rows of windows in the sides and in the ends and ample ventilation is afforded by two rows of windows which extend the entire length of the monitor.

A well-equipped laboratory is maintained and all of the raw material, as well as the metal for the castings, is analyzed. The power plant is located in a building adjoining one end of the foundry. It is equipped with an 85-horsepower gas engine, a General Electric generator set and an air compressor. Two railroad sidings parallel the length of both sides of the foundry, the one extending into the metal storage yard and the other, used for shipping castings, passes close to the sand bins.

The Gulick-Henderson Co., inspecting engineers, chemists, assayers and metallurgists, have opened larger quarters for their offices, laboratories and testing rooms in Pittsburgh at 525 to 529 Third avenue. The company's business has grown rapidly and a large amount of new machinery and apparatus has been installed. The San Francisco office of this company is located at 444 Market street.

A Difficult Crucible Steel Casting

Making large castings of crucible steel is not always easy of accomplishment, owing to the fact that the contents of a large number of crucibles are frequently required to pour one casting. Recently the Swedish Crucible Steel Co., Hamtramck, Detroit, Mich., poured a worm screw feed casting for the Morgan & Wright Co., Detroit, which was 10½ feet long and weighed 1,075 pounds with

CRUCIBLE STEEL WORM SCREW CASTING

gate and heads. The casting required eight full pots of metal. The casting, which is shown in the accompanying illustration, also involved considerable molding difficulties and the sprues were arranged so as to get the metal into the mold as speedily as possible. The fact that a green sand mold was employed is particularly noteworthy, inasmuch as dried molds are generally used in crucible steel casting work. A test bar which formed a part of the casting developed the following physical properties: Tensile strength, 78,553 pounds per square inch; elastic limit, 49,923 pounds per square inch; elongation in 2 inches, 26.56 per cent, and reduction of area, 46.41 per cent. The Swedish Crucible Steel Co. contemplates the installation of a Bessemer converter in conjunction with its crucible furnaces. The officers of the company follow: N. L. Olson, president and treasurer; Dr. A. J. W. Nixon, vice president, and J. H. Tobin Jr., secretary and superintendent.

Personal

Henry M. Lane, one of the editors of *Castings* and *Woodcraft*, published by the Gardner Printing Co., Cleveland, has resigned.

W. H. Harris, for many years foreman of the Miller Iron Co.'s foundry, Providence, R. I., has accepted a position as foreman of the foundry operated by the Lyon Iron Works, Greene, N. Y.

E. H. Wheeler, formerly superintendent of the Meadville Malleable Iron Co., Meadville, Pa., has been appointed superintendent of the malleable department of the Oliver Chilled Plow Works, South Bend, Ind.

W. S. Quigley, vice president and general manager of the Rockwell Furnace Co., New York City, has resigned and has organized the Quigley Furnace & Foundry Co., with offices at 50 Church street, New York City, to engage in the construction of furnaces for all industrial requirements.

H. L. Caley, for the past 20 years engaged in the foundry business at Utica, N. Y., has accepted a position as superintendent of the new foundry recently erected at Manasquan, N. J., by the Mackay Mfg. Co., of New York City, manufacturer of radiators and steam and hot water boilers.

John Jermain Porter has resigned from the University of Cincinnati and after June 1 will devote his entire time to consulting practice as metallurgical engineer. Mr. Porter will make his headquarters at Staunton, Va., and will give special attention to improving the operating efficiency of blast furnace, foundry, coking and other processes. In this work he will be associated with Charles Catlett, consulting economic geologist, of Staunton.

The Henry Souther Engineering Corp., Hartford, Conn., has prepared a 12-page booklet which contains notes and useful data on the selection and preparation of samples for analysis and tests. The pamphlet suggests methods for sampling brass, bronze, aluminum alloys, iron castings, steel, coal and coke and reproduces physical test specimens adopted by various technical societies.

New Processes for Chilling Gray Iron Castings*

Results of a Large Number of Experiments for the Mechanical Production of Outside and Inside Chills in Iron Castings

By Thomas D West

CONDITIONS are occasionally such that an *inside chill* is produced in castings, by which is meant that a casting with a gray or soft exterior may have the interior, or portions of it, composed of a hard, white or chilled iron, as shown in Figs. 1, 2 and 6. While inside chilling is claimed to be produced by hydraulic pressure, this is not the inside chill which has puzzled foundrymen, and prior to the mechanical creation of inside chill by the author, no one, as far as he knows, has explained how it could be produced at will. The discovery of how this can be done is due largely to experiments which the author has been conducting during the past two years with a view to overcoming the defects now existing in chilled car wheels, and this investigation led to other lines of research, which hereafter will be explained.

Most of the experiments were made at the West Steel Casting Co., Cleveland. This company makes castings by the converter and crucible methods, the former requiring a cupola similar to that used in iron founding, and this iron was used for casting chillable metals. The irons used were approximately of the following composition: Carbon, 2.75 to 3.25; silicon, 1.75 to 2; sulphur, around 0.06; manganese and phosphorus, each about 0.04. In cases where a more chillable metal was desired, small portions of stick or powdered sulphur were dropped on top of the molten metal when in the hand ladle.

Producing an Inside Chill

In Fig. 3 is illustrated the experiment that created mechanically an inside chill. This gives views of the mold used in casting test specimens in open sand of the size shown at *A*, Fig. 9. The bar, *A*, Fig. 3, was cast against a chiller block, *E*, while bars *B*, *C* and *D* were surrounded with rammed sand. The bars having been poured, the gate connections, *F*, *G*, *H* and *I* were broken and the sand around *C* and *D* was removed as soon as the solidification of the bars would permit. When it was believed that bars *C* and *D* would withstand the pressure of tongs, they were lifted quickly and *C* was immersed in water, while *D* was broken to display conditions of its interior. The immersed bar, *C*, having cooled to a dark color, was taken from the water and broken, and displayed an inside chill, shown at *E*, Fig. 1. The bar, *D*, showed an interior condition bordering on semi-molten metal. The chilled bar, *A*, showed that the chiller, *E*, had chilled the surface of *A* about ½ inch deep, while the bar, *B*, had a fine gray fracture. Bars, *A* and *B*, were not removed from their molds until nearly cold.

To mechanically create an inside chill the outside body of a casting should cool slowly enough to allow the carbon to take a graphitic form, while the inner body, which is not wholly solidified, is cooled so rapidly that the carbon is held in the combined form, similar to the way it is held in the molten metal. The graphitic state of the carbon in the solidified body causes the iron to be gray and soft, while the combined state causes it to be hard and white, or chilled.

The ability to create an inside chill by strictly physical manipulation led to the belief that it might be practicable to increase the depth of a chill beyond what present chillers can do, with like irons. Especially was this believed practicable for such castings as chilled car wheels and rolls. Several methods were devised for testing purposes, but finally those in Figs. 4, 5, 10 and 15 were adopted for the chief researches. These devices admitted of a wide range for experiments and as a rule led to satisfactory results.

The following explanation is given

*Presented at the meeting of the American Society of Mechanical Engineers, held at Cleveland, May 28-31.

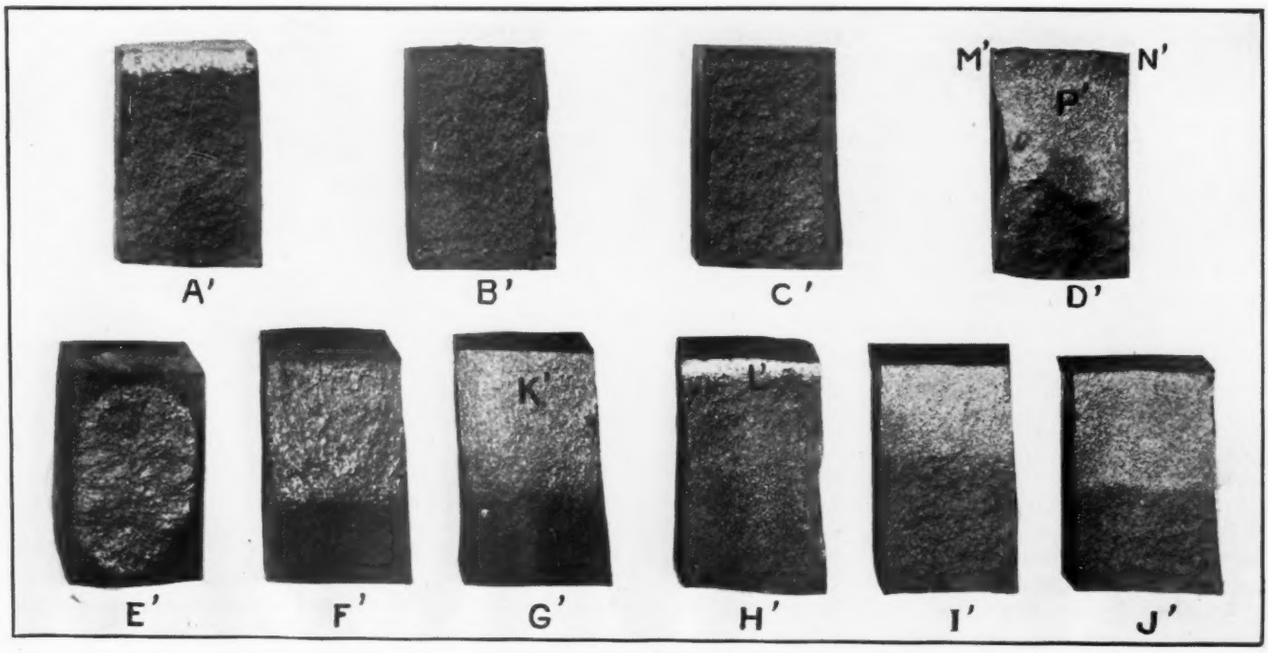


FIG. 1—CHILLED, NATURAL, MUD, WATER AND AIR-CHILLED TEST BARS

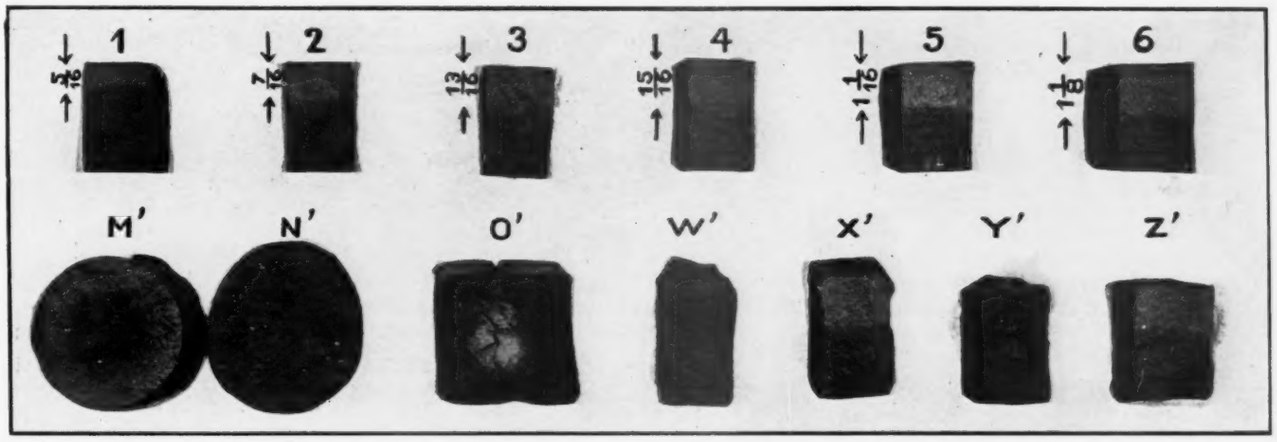


FIG. 2—THICKNESS OF CHILLER, INTERNAL CHILLING AND COOLING TEST BAR FRACTURES

of actions that take place and of conditions that exist in the process of chilling:

(a) Chillable iron is chilled prior to any formation of graphite. A chill may be made harder by continuing to cool it while the adjoining metal is still in a semi-molten state or very hot; as by this action any backward annealing to soften the chill is more or less retarded.

(b) Under like conditions, the lower the silicon and the higher the sulphur and carbon, the deeper the chill.

(c) Under like conditions, the chill will be deeper the smaller the area of the cross-section to be chilled.

(d) Under like conditions, the less the thickness in the chiller below what can be utilized, the less the chill in the casting.

(e) The longer the casting remains in close contact with its chiller while its metal is in a chillable state, the deeper the chill.

(f) The more fluid or the hotter the metal used in pouring a chiller mold, all other conditions being the same, the deeper the chill, from ⅛ to possibly ⅜ inch; and the greater the chillable nature of the metal, the more pronounced this effect.

(g) Not all grades of cast iron are chillable. It requires, as a rule, for iron of an ordinary carbon content, less than 2 per cent silicon and above 0.06 per cent sulphur.

(h) On account of the variable percentages of silicon, sulphur and carbon required to produce chilled castings, ranging from 1.75 down to 0.50 for silicon, from 0.10 down to 0.05 for sulphur, and from 4.00 down to 2.50 for carbon, it is evident that there must be what are commonly called *grades* in chillable irons.

Mold for Making Comparative Chilling Tests

In order to make comparative tests, a twin-chiller mold was designed, shown in Figs. 4, 5 and 15. By having the two molds combined so that they could be poured from the same basin, it was possible to make all the conditions alike in both, except the one which it was desired should vary for the particular test under way. The mold was further designed to produce conditions similar to those existing when casting chilled car wheels and rolls. In making these latter castings, the contraction of the chilled crust and the expansion of the chiller create a space between the exterior body of the casting and the interior face of the chiller. The ability to create a space in this experimental mold and to apply a heat-absorbing element to it in connection with other actions or treatment, referred to later, made it possible to conduct a large number of very satisfactory comparative tests.

In order to obtain a variable action so far as the chillers, *P*, Fig. 15, were

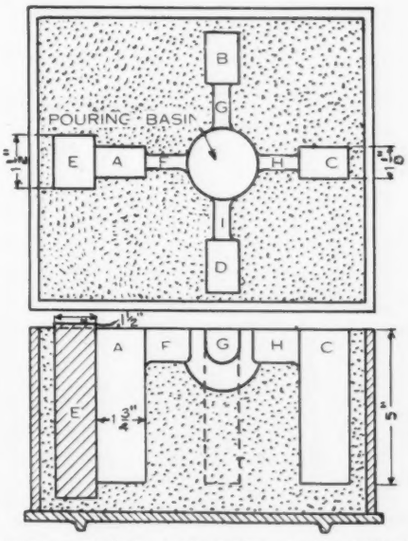


FIG. 3—MOLD FOR TEST BARS THAT SOLVED INSIDE CHILL PROBLEM

concerned, the braces, *M*, were removed and the wedges, *N*, driven down. If it were desired to have the space, *K*, in both molds, two persons were employed to work in unison at the respective ends of the molds. The wedges, *N*, were not knocked down until the metal filling the mold showed evidence at the top edge of the bars of having solidified sufficiently to produce a self-sustaining crust. It was rather remarkable in the air-cooling tests, to be described later, how clearly the rate of cooling and inner solidification could be judged by the changing color of the hot metal at the top edge of the bars next to the chillers.

In casting bars intended to be kept in close contact with their chillers, either the runners connecting the pouring basin with the mold must be broken as soon as the metal in them has solidified sufficiently to permit such action; or care must be taken when pouring the molds not to fill them any higher than the level of the bottom of the pouring runners. By these means the disturbing influence due to the contraction of the runners and pouring basin is avoided.

Fig. 9, *A*, shows the form and size of the pattern used for molding the bars, while *B* is the manipulative chiller, *P*, Fig. 15, employed in these tests. Each of these chillers weighed 3 pounds, 14 ounces, and the bars made from the pattern, *A*, Fig. 9, averaged 3 pounds, 4 ounces.

First Experiments

In starting to use the twin chiller molds shown in Figs. 4, 5 and 15, the first manipulation was to draw back the chiller, *P*, Fig. 15, of one mold about ¼ inch from the face of its bar casting as soon as the latter had solidified sufficiently to have a self-supporting crust facing the chiller, while the companion bar was left in close contact with its chiller until of a dark color.

In various tests a ¼-inch space, *K*, Fig. 15, was formed by moving back the chiller, and the effect of quickly-packing different materials into this space upon the backward movement of the chiller was ascertained. The materials tried at different times were fine sand, coke dust, charcoal, powdered manganese, bone dust, hardening powder and poisonous cyanide. These tests were made with a view of determining whether such filling of the space would increase the depth of chilling in a bar, or cause it to be any harder than when the chiller remained in close contact with the bar until the latter was nearly cold.

No noticeable effects were produced by the use of these intended hardeners. The thickness of chill of the bars kept in close contact with their chillers exceeded that of the treated bars by from ¼ to ⅜ inch. This was to be expected, as the withdrawal of the chillers, *P*, to

create a packing space, broke the contact of the chillers with their bars at the crucial moment, so far as their effectiveness was concerned in increasing the depth of the chill.

Second Experiment

In this series of tests, both chillers were pulled back at the same moment to create spaces adjacent to both bars, as at *K*, Fig. 15. The tests were made to ascertain whether any greater depth of chill or hardening was produced by packing one of the spaces quickly with the materials used in the first experiments while the other space was left open. These tests showed the chill to be from 1/16 to ⅛ inch deeper in several of the treated bars than in the non-treated bars.

Tests for hardness, except for the cyanide, showed a gain of 6 to 10 per cent by the scleroscope. One cyanide test with companion all-chilled bars averaged 68 for the treated and 70 for the non-treated; while with another set of companion bars which were not chilled the non-treated bar gave 58 and the treated bar 50 on an average. This softening action of the cyanide may have been due to the fact that the bars were not cooled in water after treatment, as is necessary when case-hardening steel with cyanide. A peculiar effect of the cyanide is to produce a denser and a finer crystallization of the treated chilled face, about ⅛ inch thick.

Immersion Experiments

For this series, open sand molds, Fig. 3, were used, and by the aid of an assistant, two of the four bars were removed as soon as the crust solidification permitted. One of these bars was immersed and moved around in a pan of mud, which in some tests had salt mixed with it, while the second bar was simultaneously submerged in a pail of water. These tests were duplicated by having the pan nearly filled with a high fire-test oil in place of the mud. Tests made by the second use of the open sand mold, Fig. 3, showed that the mud or oil-cooling had little or no effect in chilling, on the average, while the water-cooling was radical in its action, *A'*, *B'*, *C'* and *D'*, Fig. 1, give a fair illustration of these tests; *A'* is the chiller-cooled bar; *B'*, the all-sand; *C'*, the mud-cooled bar, and *D'*, the one placed in water. Bars, *A'* and *D'* were both left in their molds to cool naturally.

The bar, *D'*, displayed an inside chill as shown by the white appearance at *P'* and the gray corners and surface at *M'* and *N'*. The best example of this effect, which was closely duplicated in several tests, is shown at *E'* in connection with the chiller-cooled companion bar, *F'*, which was cast against the face of the chiller, *E*, Fig. 3, the same as bar *A'* in Fig. 1. The bar, *F'*, showed that a harder grade of iron was used than for *A'*.

The writer's experience in producing this inside chill mechanically, demonstrates it to be a sensitive process partaking of numerous forms, yet all verifying its practicability. It is not improbable that castings, or sections of them, will eventually be produced in a regular manner for commercial use, having a gray or mottled exterior crust, while the adjoining or interior body of metal will be of a mottled, chilled or white iron. The writer can conceive of castings in which this combination of hardness might prove useful, but as his ideas might be considered visionary, he refrains from mentioning them.

Special attention was paid in this series of tests to the hardening effect of air applied directly to the hot chilled face of a bar. For tests of this character it is essential that the depth of chill in the comparative bars be of the same thickness. This condition was obtained by admitting the air to the treated bar only after it was thought the inner metal had all solidified, so that it could not be held responsible for any variation of depth of chill in the treated bars. Only three specimens of this series were tested by the scleroscope, as given in Table I; but from filing and grinding tests made as a check on the results it is evident that a chill's hardness can be very materially increased by applying air, etc.

Tests of the gray sides of the chilled bars for the second and third sets in Table I gave 52 and 42, respectively, showing them to average 25.4 softer than the chilled sides which had received the air treatment.

Another series of tests was conducted with a view to learning whether air saturated with water might be more effective than air alone in creating a chill, or in hardening. There was some difficulty at the start in obtaining satisfactory saturation, but this was finally secured by the use of a device which made it possible to vary the proportion of air or water, as desired. The tests were instructive in demonstrating that so far as the chilling was concerned there was little to be gained by the saturated air, or what was gained would be secured by the use of a greater volume of air alone, so that the water could be dispensed with. This is not, however, intended to reflect upon the effectiveness of saturated air as a hardening medium, for among the tests in which saturated air was strongly applied, one gave 70 for the treated bar, and 52 for the non-treated bar, a gain of 34.6 per cent due to hardening.

Specimens of this series of tests were cast in the twin chiller mold, as arranged in Fig. 5, without applying any air-cooling to either chillers. This

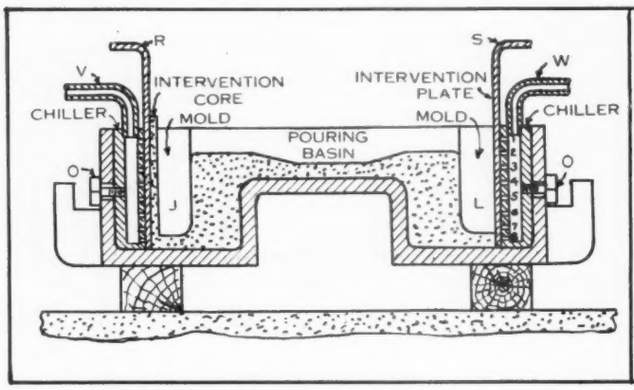


FIG. 4—INTERVENTION PLATE SYSTEM FOR AIR-COOLING AND CHILLING MOLTEN METAL

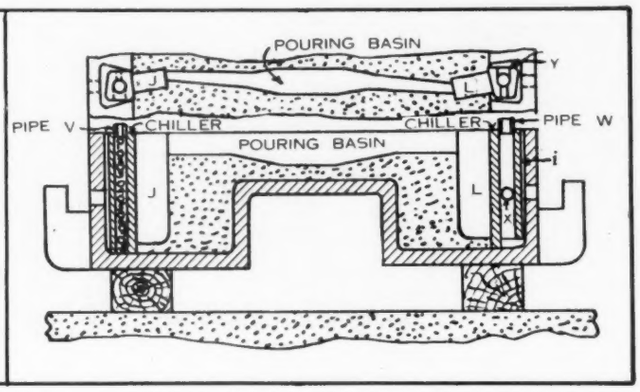


FIG. 5—CHILLER MOLD FOR TESTING CHILLING EFFECT ON CASTINGS BY COOLING CHILLER

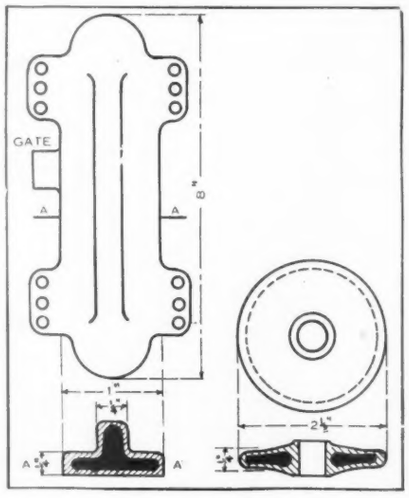


FIG. 6—CASTINGS WITH GRAY EXTERIOR AND CHILLED INTERIOR
Shaded Lines, Gray or Soft Iron; Black, White or Chilled Iron

gave the same depth of chill in both bars. Several sets were cast and annealed, but only one set was tested by the scleroscope. Other sets showed by filing and grinding that they checked closely those tested by the scleroscope. The annealing was done as follows: The bars were taken out of their mold together and one left in the open air, at about 70 degrees Fahr., while the other was laid on the bottom of a hot crucible furnace, the oil fire having been shut off, and left there about 12 hours. The chilled side of the unannealed bar tested at 68 and the gray side at 45. The chilled side of the annealed bar tested at 47 and the gray side 35. This gave a difference for the chilled sides of 21 and for the gray sides of 10.

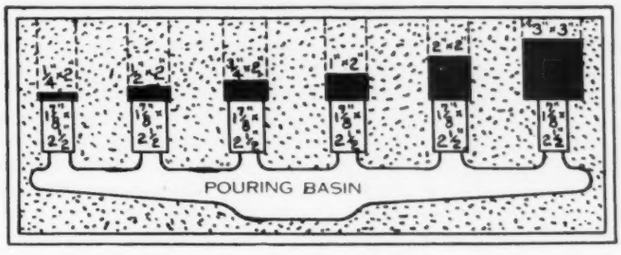


FIG. 7—TESTING EFFICIENCY OF DIFFERENT THICKNESSES OF CHILLERS

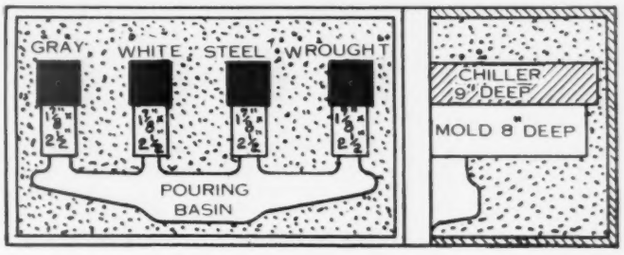


FIG. 8—TESTING EFFICIENCY OF DIFFERENT METALS FOR CHILLERS

In order to be assured of correctness in his researches, the author undertook to determine the efficiency of different metals, and of different thicknesses of metal, for chillers and the relative efficiency of warm and cold chillers.

To determine this, the latter two chillers, both alike, were used, one of which was heated to various temperatures, from one bearable to the hand to one that would burn the flesh, while the other chiller was kept at the temperature of the atmosphere. The first three sets of these tests were made on a day when the thermometer registered 62 degrees, and the second set of four tests when it was 55 degrees. The tests showed from 1/16 to 3/16 inch greater depth of chill in the bars having the cold chiller than those having the heated ones. Having recently read the claim that a warm chiller would chill deeper than a cold one, it was thought necessary to learn whether such was a fact, as it is unreasonable to expect such a result.

To determine the effect of different thicknesses for chillers, tests were made by the writer at the Cleveland plant of the National Car Wheel Co., as well as at the foundry of the West Steel Casting Co. For this series open sand molds were used, as shown in Fig. 7. The chillers were, respectively, ¼, ½, ¾, 1, 2 and 3 inches thick, and all were 2 inches wide by 9 inches deep.

The test specimens cast against these chillers in the wheel foundry were 1⅞ x 2½ inches and 8 inches long, and at the steel foundry, because of having a less chilling metal, they were of the size shown at *A*, Fig. 9. The top row of fracture views, Nos. 1 to 6, Fig. 2, is a fair representation of the results obtained. The thickness of chill in the samples shown in Fig. 2 is approximately as marked. A study of these samples demonstrates that the efficiency of chillers in general use is far from being in accord with their thickness. The 3-inch chiller, for example, produced only 3/16 inch more depth of chill than the 1-inch chiller.

Aside from their value in other ways, these tests suggest the advisability, to makers of chilled rolls, car wheels, etc., of trying steel chillers in place of the much heavier cast iron chillers. Steel chillers need be made only of the thickness required for efficiency in cooling and would still be strong enough to resist the contraction and expansion strains to which chillers are subjected. There is a liability of difficulty being encountered in using steel chillers on account of the steel warping, much more than cast iron, through repeated heating. By using ribs or giving a special form to steel chillers this objection may be greatly reduced, if not wholly overcome.

Efficiency of Different Metals for Chillers

It was important, at least to the writer, to know whether any difference existed in the efficiency of chillers of gray, white or all-chilled cast iron or of steel or wrought iron. Tests were made with these different metals at both foundries. Two tests of chillers were used, one 2 inches square and the other 1 x 2 inches, all approximately 9 inches long. Aside from grinding one face of these chillers to remove the scale and to make them smooth, as was done with all other chillers used in these experiments, they were chipped or ground at their lower ends, if needed, to make them all of the same weight. The plan of the open sand mold used is shown in Fig. 8. The test bar patterns were of the same size as used for the tests, Fig. 7, about four sets being cast from each size of pattern. While slight differences in the thicknesses of the chills resulting from chillers of the different materials seemed to indicate that one or another of the materials produced the deepest chill, there was so little practical difference in the results, taking an average of all the tests, that none of the chillers could be rated as being decidedly better than the others.

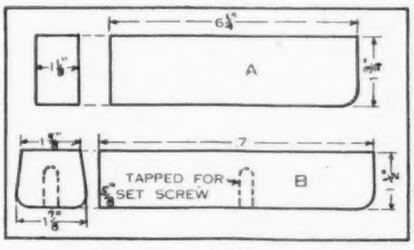


FIG. 9—FRACTURE TEST BAR PATTERN *A*; MANIPULATIVE CHILLER, *B*

The chief information sought in this series of tests was whether, when a casting contracts away from a chiller, the depth of chill is increased by cooling the chiller, and at what point the cooling ceases to have this effect. The chillers for these tests were arranged so as to have the orifices 1 to 8, Fig. 4, turned away from the face of the mold as in Fig. 5. This gave a solid surface to the body of the chiller fronting the mold, and prevented the air used to cool the chiller from impinging on the hot face of the bar. For the first tests, intervention plates, *S*, were used for fronting each chiller. As soon as the solidification of the metal at the face of these plates would permit, they were pulled out simultaneously to create a space between the bars and their chillers, as seen by the opening at *K*, Fig. 15. When the plates, *S*, were removed, air at about 50 pounds pressure was admitted to one of the pipes, as shown at *W*, Fig. 4, which passed down the bore of its chiller to find exit at *X*, and at the orifices *1* to *8* to the exterior of the chiller; then it passed upward and escaped to the atmosphere from around the opening, *V*, shown in the plan view, Fig. 5.

In the use of chillers for car wheels, rolls, etc., the contraction of the casting and expansion of the chiller leave a space between the two, and these tests were, therefore, well-adapted to demonstrate whether internally or extenally-cooled chillers used for this class of castings would produce a deeper chill than those not cooled. Six tests were made without finding any practical difference in the depth or character of the chill produced by the air-cooled chiller bars and that of their companions which were not cooled.

Following these tests, fully six more were made with the plates, *S*, omitted on both sides, so as to have the bars cast directly against the face of their chillers, as illustrated in Fig. 5. Here both bars remained in close contact with their chillers until cooled to a

dark color. In casting these bars, air at about 50 pounds pressure was admitted to one side only, passing down the pipe, *W*, and escaping at the lower exits, shown at *X*, then passing upward to the external atmosphere through the space, *I*. This method proved practically no more effective in increasing the depth of a chill than that just described, and appears to confirm the tests illustrated in Fig. 7, demonstrating that there is a limit to which the thickness of a chiller affects its efficiency. They forcibly illustrate the fact that it would be unreasonable to expect any benefit from a heat-absorbing medium passing rapidly through the internal body of a chiller or over its outer external surface, when a space existed between the casting and its chiller.

Chilling Produced by Sand-Faced Molds

It was desired to ascertain whether a chill could be created by air under pressure when prevented by a sand coating from getting directly at the hot surface of a casting. To test this, the methods illustrated in Figs. 4 and 10 were used, the two last of which were experimented with at both foundries. In using the mold shown in Fig. 4, an intervention core was employed, as seen at the left. This core was about ¼ inch thick and was well-wired so that the head pressure of the molten metal could not break it, when the plates, *R* and *S*, were pulled out together after pouring the molds. The first test of this series demonstrated the porosity of a sand mold's surface. Although this was a very hard core, the 50-pound air pressure used carried the air through it and would have blown all the metal out of its mold had not the valve been closed. The companion bar withstood the air pressure for the reason that

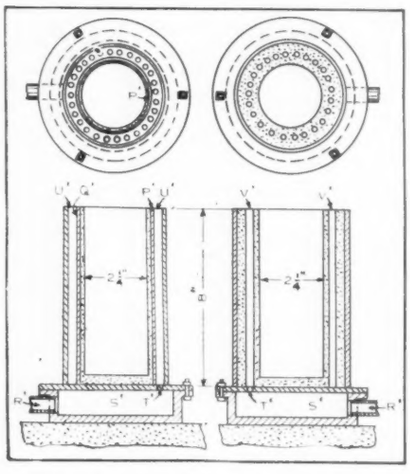


FIG. 10—PIPE SAND COATED, AIR-CHILLING MOLD AT LEFT, ALL SAND, AIR-COOLED MOLD AT RIGHT

the plate, *S*, had formed a chilled crust on the face of the metal in the mold before its removal. Further tests with these cores under different air pressures showed that the cores prevented any chilling action, while on the other hand the air was very effective on the opposite side.

The difficulty with this core method lies in the fact that air under sufficient pressure to penetrate the core and carry off heat and to create external chill

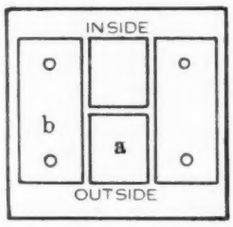


FIG. 11—FLOW OF HEAT RETARDED BY JOINTS

will pass clear through the molten metal instead of forming a crust and then chilling it. This led to devising the method shown in Fig. 10. By a study of the sand-coated pipe, *P'*, it can be seen that any pressure up to 200 pounds and over can be employed without causing the air to impinge against the molten metal, while at the same time it can be more effective than the core itself in conveying heat to its outer surface and then to the atmosphere. The sand coating used on this pipe was only ⅛ inch thick and was thoroughly dried. To carry off the gases from the sand, the iron pipe was closely perforated with 3/32-inch holes as at *Q'*.

Air under 60 pounds pressure entered at *R'* to the chamber, *S'*, and passed up through the holes, *T'*, surrounding the pipe, *P'*. The air in the chamber, *U'*, was free to absorb heat from the pipe, *P'*, and to carry it rapidly to the atmosphere. The molds were poured without any cope or covering, care being taken to fill them only within ½ inch from their tops. In about 10 seconds after pouring the mold, the air was admitted and kept in action until after all the metal was thought to have solidified. A fair illustration of the results obtained is shown at *M'*, Fig. 2. An all-sand molded, non-treated companion bar was always cast from the same ladle that poured the treated bar. A sample of this is seen at *N'* at the right of *M'*.

There is little doubt but that the pipe, *P'*, acted as a chilling agent without the use of air, as there was only ⅛ inch thickness of sand between it and the face of the casting. In fact, a test made without the air showed that the pipe aided the chilling, since it gave a density to the crust of the casting. Again it is to be kept in mind that as the diameter of the casting was only 2¼ inches, its contraction would not be sufficient to create a visible space between its outer body and the face of the mold, as is generally created in casting chilled rolls, car wheels, etc.

In the all-sand mold, *Y*, Fig. 10, which was also tried, the air passed up through holes, *T'*, which were ¼ inch in diameter and about the same distance apart, all around the circumference, as shown in the plan view. The air escaped freely around the top at *V''*. The holes, *T'*, had only about 3/16 inch thickness of sand between their inner exterior and the face of the mold. Castings produced by this method showed a dense exterior or crust of from ⅛ to ⅜ inch thick, and in some instances were slightly mottled. Only in one case was there any display of chill, and this was of an irregular character, ⅛ to ¼ inch thick, created inside of a gray crust, about ⅛ inch thick. In reality, this was an example of inside chill, one of the factors sought in these experiments being to learn if by such methods it could be produced at will and if it was controllable.

It was intended also to form holes as at *I''* with very thin pipes drilled closely full of 3/16-inch holes, and if a steady pressure of 100 to 150 pounds of air could have been secured, further efforts to learn the practicability of obtaining an inside chill with such, or similar, methods would have been tried.

A study of the principle embodied in Figs. 4 and 10 will suggest ideas and ways and means by which grades of soft iron, aside from chilling iron, can be made more dense or crust-hardened; also by which castings or sections of castings may be cooled to prevent contraction cracks and shrink holes.

Effect of a Joint on Transmission of Heat

It is evident that in constructing chillers to be cooled by air, etc., sufficient consideration has not been given to the question of transmission of heat. An excellent article by Carl Hering on "The Flow of Heat Through Furnace Walls"[1] might be read with advantage in connection with this paper. Its author offers among other features the illustration shown in Fig. 11, with the following comments:

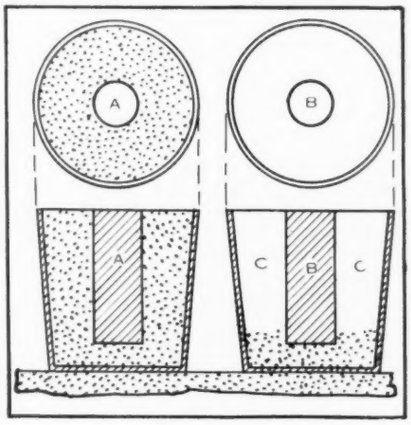


FIG. 12 — TEST BAR CAST IN OPEN SAND AND LATER FREED OF SAND AND SURROUNDED BY WATER

"Moreover, the writer noticed recently in an electric furnace that the temperature of the brick at *a* in the sketch was considerably cooler than at *b*, the difference was so great that it was easily noticeable to the touch. This was

[1] *Metallurgical and Chemical Engineering*, September, 1911.

no doubt due to the joint which separated the one from the inside of the furnace."

The principle illustrated in Fig. 11 is similar to that involved where such spaces exist as at *K*, Fig. 15, which greatly retard the absorption by the chiller of heat from the castings. It all emphasizes the utility of filling such a space as *K* with a heat-absorbing medium that can be moved swiftly from an inlet to an outlet to carry off heat for cooling, hardening or chilling purposes.

It is believed that a study of the conditions will show that a rapid passage of air or other heat-absorbing media through a space as at *K*, Fig. 15, or over the surface of a casting, is very efficient for the purpose of extracting and conveying heat quickly both from the face and adjoining body of a hot casting.

Heat Conductivity of Sand, Iron and Air

These tests were made for the purpose of ascertaining the heat conductivity of molds, composed of a sand body, and again of iron, as in chillers, instead of having a heat-absorbing medium impinge directly against the hot surface of a casting with exits for the rapid escape of the medium to the atmosphere. The tests for sand conductivity were made by constructing a dry sand core, 1½ inches square by 7½ inches long, with a ⅝-inch port hole lengthwise through the center. This core had part of the outer face of one end cut away to provide an exit for the air forced through the interior of the core. When placed in position, the core appeared practically like the chiller, shown at the right, Fig. 5. The tests for iron conductivity were made by having a chiller with a solid face and other conditions of its position, shown at the right, Fig. 5.

In conducting these tests for the sand and iron, as well as with air impinging against the surface of the hot castings, only one end of the flask for twin molds was used. The mold, *L*, was formed with the same pattern, *A*, Fig. 6, which was used for making all other bars. The molds were poured by a direct flow of the metal from the lip of the ladle. The top of the bars having been covered with sand and a plate to confine their heat so that the thermometer used would read correctly, the air-flow was started down the interior of the core or chiller and found an escape at the opening, *X*, and up the sides, *I*, to the top around *Y*, thence to the atmosphere, as shown at the right, Fig. 5.

Table I.

SCLEROSCOPE TESTS FOR HARDNESS[2]

Set Number of Tests.	Set 1	Set 2	Set 3
Average of air-cooled chilled bars	56	65	61
Average of natural-cooled chilled bars	48	58	53
Average of increase in hardness effected	8	7	8

To obtain the temperature of the escaping air, the bulb of a thermometer capable of registering 500 degrees was held directly above and resting on the surrounding sides of the open space at *Y*. An assistant recorded the time

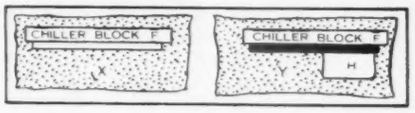


FIG. 13 — MOLD FOR CASTING A CHILLED PLATE AT *X*; *Y*, MOLD WITH SPACE, *H* FOR MOLTEN METAL

and the varying temperatures of the escaping air at the first 15 and 30 seconds and afterwards each minute, as indicated in Table II. At the end of 10 minutes the bulb of the thermometer was held at one end of the inlet pipe after it was disconnected in order to obtain the record, *4*, in Table II. At the end of *2* minutes, and after the plate and sand had been removed from the top of the bar, the bulb of the thermometer was placed so that its frame end rested on the middle of the top end of the bar for 3 minutes, that the natural radiation of heat from the bar, record *17*, Table II, might be recorded. The variations in pressures and temperatures, records *3* and *4*, are due to changes in the speed of the compressors and to the amount of air being taken from the tank for other purposes. The apparent inconsistency of the temperature dropping at the start to only 80 degrees and 94 degrees, while that which came from the tank of the compressors is 134 degrees and 124 degrees, as in record 4, is due to the temperature of the core and chiller at the start, being that of the atmosphere, as shown in record *2*. For these reasons, the in-going air is for a few moments reduced in temperature.

A study of Table II shows the sand to be the least effective as a conductor of heat, while the iron is not very much better when compared to the conductive power of air applied directly to the surface of the hot bar, as recorded in *17*, Table II, where it is seen that from the moment the air impinged upon the surface of the hot bars its temperature rose and in less than 30 seconds after the mold was poured it reached 200 degrees.

Experiments Upon Direct Application of Heat-Absorbing Media

The following experiments were largely responsible for patents granted May, 1912, and pending, covering direct-cooling and treatment processes by pressure or suction for chilling, hardening and relieving internal strains in castings, etc. These are to be utilized wherever a space can be formed adjacent to a casting, either artificially or by the natural expansion of the chiller and contraction of the casting, also when the hot surface of a casting is freely exposed to the atmosphere or not surrounded by its chiller.

Two twin molds were used for the experiments, each having intervention plates placed as at *S*, Fig. 4. After the two molds were poured from the same pouring basin, and a crust was formed on the face of the bars, the two plates were quickly and simultaneously removed from the mold, forming spaces, *K*, Fig. 15. For the first experiments air at 20 pounds to 30 pounds pressure was admitted to one of the pipes, *W*, Fig. 4, and conveyed directly to the space created by the removal of the plates, *S*, through orifices *1* to *8* in the bore of the chiller. The fast darkening of the top edge of the face of the treated bar, compared with that of the companion bar which was cooling naturally, gave good reason to expect considerable difference in the depth of chill and in the density or hardness of the chilled face of the two bars. The intervention plates, *S*, were 2 inches wide by ⅛ inch thick. A slight coating of oil was given the faces of these plates next to the bars to prevent their uniting with the metal, and to permit their being drawn out of the mold quickly at the right moment.

Experiments with Cooled Air

Experiments were further made with air cooled by passing through a pipe coil surrounded by a mixture of two parts of cracked ice and one part of salt. The temperature was reduced thereby from 85 to 45 degrees, but no greater chilling effect was discovered in the six tests conducted on this plan than in the first series with the air as it came from the tanks. This is, as would be expected, since the reduction of the temperature of the air by 40 degrees is small in amount compared with the temperature of 2,000 degrees, which it may be assumed the surface of the molten bar would have. An increase in the pressure or volume of the air would easily discount all that could be accomplished by lowering the temperature of the air to 40 degrees.

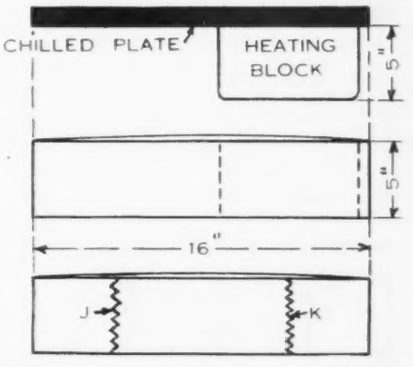


FIG. 14—CHILLED PLATE, WITH HEATING BLOCK ATTACHED, AND SEPARATED CASTING

Tests also were conducted with air at higher pressures. At 50 pounds pressure a chill was created for a depth of 1⅛ inches in the air-cooled bar,

[2]The writer is indebted to the Cleveland Punch & Shear Works, Cleveland, for these scleroscope tests.

whereas the naturally cooled bar had a depth of chill of only ⅛ inch, as shown respectively at *K'* and *L'* in the bars, *G'* and *H'*, Fig. 1. The gray body of both of these bars displayed a fine texture bordering on a mottled state. This test removed every possible doubt of the efficiency of air-cooling for chilling. Half a dozen or more of these tests were made before taking up others, and they all verified the results of the first tests.

Later, tests of the same character were conducted by having titanium and vanadium in the metal. Two sets of these samples are shown at *W'*, *X'*, *Y'* and *Z'*, Fig. 2. Here, as in *G'* and *H'*, Fig. 1, the air was by far the most effective in chilling. The air-treated bars showed about ⅞-inch depth of chill whereas their companions had only about ⅛-inch chill.

In line with these tests, a series was made to determine whether air chilling was more effective than chilling by means of a solid chiller held in close contact with its bars. Samples of bars contrasting these two methods are shown at *I'* and *J'*, Fig. 1, the air-cooled bar at *J'* having ¾-inch chill, while the other at *I'*, produced by the close contact chiller bar, has 9/16-inch chill.

Chilling of iron must be accomplished prior to the formation of graphite, and with like irons the quicker and more penetrating the cooling action, the deeper and harder the chill. The direct application of a heat-absorbing medium to the surface of a hot casting, as soon as contact with its chiller is broken, or a crust is formed, provides means at a critical moment which cannot but be of material benefit in increasing the utility of cooling, densifying or chilling and hardening of chillable and other grades of cast iron. It also provides means for using a softer, lower chilling and a stronger iron in car wheels, etc., obtaining at the same time the desired depth of chill.

It always has been believed that in chilling iron, the action ceased the moment the molten metal solidified. The writer's recent experiments show that such is not the case, but that with chillable iron there exists a period of 20 to 30 seconds or more when iron can be chilled, after the formation of a crust before any graphite is separated out. This was demonstrated as follows: At *A*, Fig. 12, is shown a casting poured in open sand, while at *B* it has been freed of its sand, this being done about 2½ minutes after the casting was poured. Space, *C*, was filled immediately with cold water, kept running until the casting was cold.

Upon breaking the specimen it was found, if of a high chilling iron, to be a homogeneous body of all chilled or white iron with a discolored or reddish center. But if, instead of surrounding the specimen with water at the expiration of 2½ minutes, there were allowed to lapse 3 to 3½ minutes before doing so, the crust exhibited graphitic formation, while the interior body was found to exist in a mottled or all-white state, showing the inside chill to have been created.

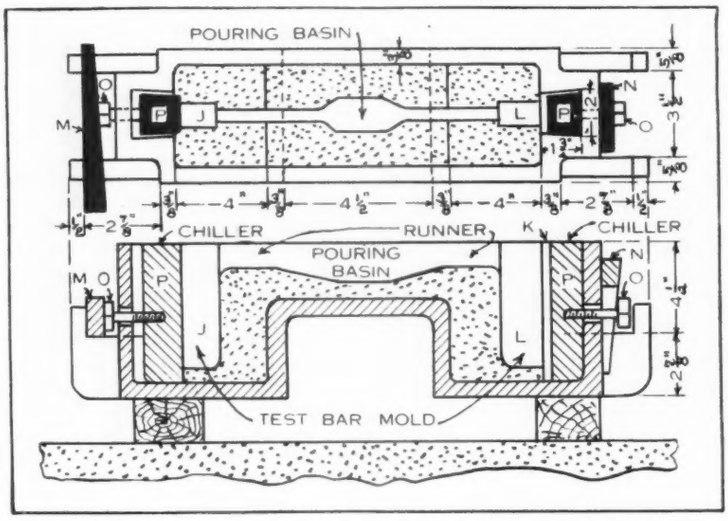


FIG. 15—MOLDS FOR MAKING CHILLED TWIN SPECIMENS FOR FRACTURE TESTS

These tests indicate the existence of two laws positive in their action, as follows: First, cooling or chilling is effective in creating or continuing a chill in a casting for a period of 20 to 30 seconds after its molten metal has solidified. This permits a continuation of chilling with castings like rolls and car wheels which break contact with their chillers immediately after the formation of their chilled crust. Second, graphitization having once taken place in the crust or body of a hot casting, no sudden cooling can restore the carbon to its original combined form, and only by remelting can it be so transformed as to have a chilled or white iron structure.

With chillable irons any founder can produce a casting having an outside chill with a gray interior, but to produce one having a gray exterior and inside chill, or white body, is another proposition. Mention has already been made of the sensitive nature of this accomplishment. The variable conditions that must be considered and accurately controlled to create a perfect inside chill are as follows: (a) Temperature of the pouring metal; (b) temper of the sand; (c) atmospheric conditions; (d) nature of the iron; (e) size of the specimen; (f) temperature of the water; (g) whether the specimen remains stationary in its mold to be cooled or is removed or moved about in a body of water.

When it is realized that, for example, with the size of a specimen shown in Fig. 3, there are only some 5 to 10 seconds in one minute when the perfect inside chill can be created, all students of this problem will realize that at present it is a hit-and-miss process. The writer has deemed it necessary to give all the above facts, so that anyone undertaking to produce an inside or internal chill will not be led to affirm it an impractical achievement. It will be well to state that the writer is of the opinion, that when one can obtain a medium chilling iron in place of the extremes, such will be best for creating an internal chill.

Internal Chilling Tests with High Silicon and Soft Casting Mixtures

Tests made by the writer, assisted by W. J. Strangward, superintendent, at the Forest City Foundry & Mfg. Co., Cleveland, showed that the high silicon in this company's light work mixtures caused graphitization to take place almost immediately, if not at the moment, of solidification, as the specimens exhibited no white or even mottled internal structure in any of the tests. Other tests made at the Madison Foundry Co., Cleveland, upon supposed non-chilling mixtures with silicon around 2 per cent and sulphur under 0.08 showed that these percentages of silicon and sulphur marked the division between chilling and non-chilling irons of the usual good working grade of foundry mixtures. The tests showed that if internal chilling could be produced with mixtures having from 2 to around 3 per cent silicon, there was a possibility that something was wrong with the physical or the chemical properties of the mixtures.

A feature of these tests with soft irons was that they showed a swelling in place of a shrinkage in their tops; also a greater fluidity of metal, or length of time before solidification took place. Although these bars were only about 1½ inches in diameter, they remained in a liquid state about as long as specimens 2¼ inches in diameter cast of the chillable car wheel metal.

Founders and engineers interested in castings for machining, etc., might often utilize internal chilling tests to advantage, as a means of determining whether there is anything in the chemical or physical properties of mixtures likely to cause chilled edges, hard spots, etc., instead of waiting for this to be found

out in the machine shop. The writer suggests as a standard for such tests, bars 1½ inches in diameter and 6 to 8 inches long for mixtures ranging from 1.25 to 3.5 per cent silicon and bars 2.4 inches in diameter and of similar length, for mixtures having from 0.5 to 1.25 per cent silicon. In making internal chilling tests, care must be exercised not to immerse a specimen in water until a self-supporting crust has been formed, or an explosion of liquid metal may occur. The use of a fair amount of intelligence and caution will guard against such dangers.

Internal Graphitization of a Chilled Crust

Being desirous of knowing whether, after the greatest depth of a chill is created, it is possible for the intense heat of an internal body of semi-molten or solid metal to decrease the depth of a chill by graphitization, or drawing the chill, the writer conducted the following experiments: An open sand mold having a chiller block, *F*, was used, as shown at *X*, Fig. 13. The open sand mold was formed by plate patterns, ⅝ and ⅞ inch, respectively, both being about 5 inches deep and 16 inches long. After the plates were poured and solidified, a space was dug out for about half their length, as seen at *H*, Fig. 13, *Y*. This space was filled with molten metal, left in close contact with the chilled plates until cooled to a dark color. The molten metal was of regular car wheel mixture, and the tests were conducted at the National Car Wheel Co.'s plant.

Tests were made with the plates at different temperatures from that at which the molten metal would fuse the face of the plate, down to temperatures at which the plates were of a dark color. Upon removing these plates and body blocks of metal from the molds, the chilled plates would be separated from the blocks of metal and broken at about the points, *J* and *K*, Fig. 14, to display any contrast that might exist due to the treatment. Only in one case was the plate inseparable, and in this instance the plate and block were broken by a heavy drop block.

In all of these experiments a drawing of the chill in depth was displayed by reason of the hot molten metal causing a graphitization of the chilled face abutting it. The experiments made with the hottest plates showed the greatest effect, and such as to produce about a 25 per cent graphitization of the chilled plates face that abutted the hot metal. This effect was exhibited by a fairly uniform decrease of the graphitization down to the coldest plates, which showed but a slight effect of the treatment.

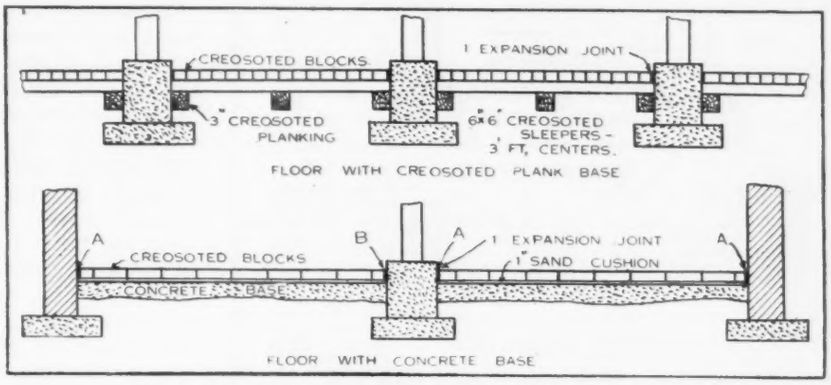
Table II.

TEMPERATURE TESTS MADE OF THREE CASTS, OCT. 23, 1911

Record No.		Sand Core.	Chiller.	Face of bar.
1	Body cooled with air			
2	Temperature of atmosphere, degrees Fahr.	52	52	52
3	Pressure of air used, pounds	55	50	50
4	Temperature of tank air, degrees Fahr.	134	124	130
5	Temperature escaping air at 15 seconds	80	94	...
6	Temperature escaping air at 30 seconds, degrees Fahr.	100	112	200
7	Temperature escaping air at 60 seconds, degrees Fahr.	116	142	290
8	Temperature escaping air at 2 minutes, degrees Fahr.	120	162	310
9	Temperature escaping air at 3 minutes, degrees Fahr.	126	182	290
10	Temperature escaping air at 4 minutes degrees Fahr.	130	182	270
11	Temperature escaping air at 5 minutes, degrees Fahr.	134	178	264
12	Temperature escaping air at 6 minutes, degrees Fahr.	136	176	252
13	Temperature escaping air at 7 minutes, degrees Fahr.	138	172	236
14	Temperature escaping air at 8 minutes, degrees Fahr.	140	170	222
15	Temperature escaping air at 9 minutes, degrees Fahr.	140	166	200
16	Temperature escaping air at 10 minutes, degrees Fahr.	138	162	192
17	Heat radiated from the bars 15 minutes after they were poured, degrees Fahr.	208	172	70

A New Type of Foundry Floor

Creosoted wood blocks have been in use for paving streets and as flooring for machine shops, warehouses and factories, for a sufficient number of years to demonstrate their value for all purposes where a floor that will withstand severe usage is required. Recently these blocks have been introduced as a material for paving foundry floors by the Kettle River Co., Minneapolis, which makes a specialty of their manufacture. Creosoted wood block floors have been installed in a number of foundries with such satisfactory results that their more extended use may be anticipated in casting plants where other than a sand floor is required. This is the case in brass and aluminum foundries, and in shops producing light gray iron and malleable castings. In these plants large floor areas are frequently covered with wood, even when incombustible materials are used for the casting floors, as concrete and brick make too cold and inelastic a flooring to be physically comfortable under the feet of the molders.



SECTIONAL VIEWS OF CREOSOTED WOOD BLOCK FLOORS

Creosoted wood blocks are made of southern yellow pine and northern tamarack. The preservative is creosote and is forced into the pores of the wood by pressure, rendering the blocks impervious to moisture and decay. The blocks are laid with the open grain vertical so that the wear consists of the compression of the wood fibers, and amounts to ⅛ inch in six years under heavy traffic in city streets. The floor is smooth as the blocks are small, of uniform depth and have square edges. They are laid with close, tight joints, and as shown in the accompanying illustration may be laid either on a concrete or a plank base. In the latter case, if the floor is close to the ground, the planking and the stringers should be creosoted also, otherwise they will decay and will limit the life of the block flooring.

Concrete makes the best foundation and the blocks should be laid on a bed of sand on a concrete base as shown at *B*, in the accompanying illustration. Space for expansion should be allowed at the angles formed by the blocks and walls, as shown at *A*. The blocks, it is claimed, become harder with age, and after the lapse of a year are stronger, harder and better than when first laid. These floors may be laid without skilled labor.

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Shot in Gray Iron

NUMEROUS investigators are now inquiring into the causes underlying the formation of shot in gray iron castings, and while many reasons have been assigned for the development of this phenomenon, the opinions are so conflicting that they are almost worthless when considered as a whole. A well-known English investigator claims that in all instances which have come under his observation, the iron in which the shot was found was highly carbonized and not especially high in silicon. He claims that the extrusion of shot into cavities results from the contraction of the already solidified portion of the casting which squeezes the still molten eutectic into the cavities. Furthermore, he found that the specific gravity of the shot is practically the same as that of the remainder of the metal and for this reason it will not rise to the surface with the remainder of the impurities.

* * *

Originality Rewarded

THE detachable open-hearth furnace represents the latest development in the construction of iron and steel melting and refining equipment, and in novelty of design and operation, it is strikingly original. As explained elsewhere in this issue, the melting chamber serves not only as the melting and refining medium, but is utilized also as a ladle for pouring the metal direct into the molds. This prevents lowering the temperature of the metal by first pouring it in the ladle, or chilling it, as frequently occurs as a result of this operation. The furnace imparts a higher temperature to the metal than is otherwise obtainable and the iron or steel is poured directly into the molds without loss of the initial heat, thereby practically eliminating blow-holes and permitting of the casting of light, thin sections, heretofore believed almost impossible of accomplishment with ordinary open-hearth steel. For many years, W. M. Carr, designer of this type of furnace, has labored unceasingly with one end in view, and the fact that he has placed his operations on a practical, commercial basis proves the success of his thorough investigations and many experiments.

* * *

Trade Outlook

IN ALL of the leading foundry centers an acute scarcity of common labor is reported and many shops could materially add to their tonnage provided their working forces could be increased. Malleable and steel casting plants are enjoying a better demand for their product than at any time in the last two years. This is due, in large measure, to the buying of the railroads and the increased requirements of machinery builders. Many brass shops are idle, owing to the strike of the brass molders, which has reached extensive proportions, but the plants that have acceded to the demands of the men are operating in full. Pig iron buying has been limited during the month, although the insistent demands for iron received by the furnaces from the foundries reflect a continued heavy melt. In the leading iron producing centers, No. 2 foundry is quoted as follows: Cleveland, $13.25 to $13.50; Pittsburgh, $14.15; Chicago, $14.50; Philadelphia, $14.75; Cincinnati, southern Ohio coke grades, $14.25; Buffalo, $13.75, and southern, Birmingham, $11.

Equipment for the Foundry and Pattern Shop

Shockless Jar-Ramming, Roll-Over and Pattern Drawing Machine—Furnace Burner—Grab Bucket—Jar-Rammer With Roll-Over and Pattern Drawing Equipment

A COMBINATION shockless jarring, roll-over and pattern-drawing machine of an exceedingly ingenious design, is now being built by the Tabor Mfg. Co., Philadelphia. This type of molding machine is especially adapted for work requiring a deep flask and for patterns having very little draft. The ramming of the mold is effected by jarring, the machine being of the shockless type and has incorporated in it all of the features of the Tabor shockless jarring machine. Only sufficient foundation is required to carry the dead weight of the machine, together with the flask that is to be handled. The main valve for the jarring operation is of the piston type, especially designed for the service it is to perform and is governed by a piston valve.

The piston in the main valve is actuated in both directions by intermittent air pressure supplied through the pilot valve, thus giving the delayed action required for a complete exhaust and thereby not subjecting the main valve to the impact of reversing stops. The quick admission of air at full working pressures permits of its use expansively with table loads less than maximum, thus maintaining a completely uniform efficiency per cubic foot of sand rammed, regardless of the weight of the load.

A view of one of these machines with the pattern board in place ready to receive the flask is shown in Fig. 1. The molding machine illustrated has capacity for handling molds having a total weight of 2,000 pounds and has 12-inch straight pattern draft.

Making the Mold

In Fig. 2 the flask and sand frame are in place and are filled with sand ready for jarring the mold, the machine striking blows automatically at the rate of approximately 110 per minute. After the mold has been jarred, the frame is removed and is butted-off, the bottom board being rubbed in place and clamped. The valve operating the roll-over is then thrown open, thus rolling over the mold onto the receiving table ready to be bedded preparatory to drawing the pattern. In Fig. 3 the mold is shown while it is being rolled over and in Fig. 4 the rolling over operation has reached its final limit and the mold is in position to be bedded.

The method of bedding the flask after it is rolled over is exceedingly simple and quick of operation. The receiving table, which is mounted on a movable guide and is raised and lowered by a hand wheel, shown at the left of the operating stand in the various illustrations, is adjusted to the proper position to receive flasks of the depth in use on the machine, being left in this position until a flask of a different depth is employed. When the mold is rolled over, the roll-over frame engages with stops that hold the pattern board and the flask in a perfectly horizontal position and the battens of the bottom board do not quite engage with the sliding wedges carried on the receiving table or flask support. When the flask is in this position, a small valve on the operating stand is opened, admitting air to the small cylinder operating the leveling wedges, which are arranged in such a manner that when one wedge engages with the bottom board it stops and permits the other wedge to move forward in engagement with the battens, thus insuring the perfect bedding of the flask.

The flask clamps are next removed and the vibrator is set in motion, the pattern being drawn by compressed air operating in the shock-absorbing cylinder which causes the plunger, with its table and roll-over mechanism, to rise vertically until the pattern is clear of the mold. A view of the pattern drawn from the mold is shown in Fig. 5. The roll-over table then returns to its normal position, Fig. 6, ready to receive another flask, while the finished mold is on the receiving table ready to be removed to the floor. All of the operations can be controlled by one man and all of the levers, it will be noted, are conveni-

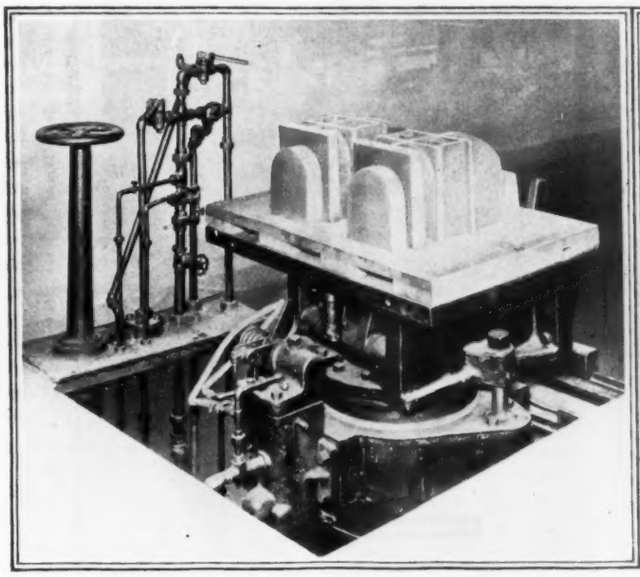


FIG. 1—SHOCKLESS JARRING, ROLL-OVER AND PATTERN DRAWING-MACHINE READY TO RECEIVE FLASK

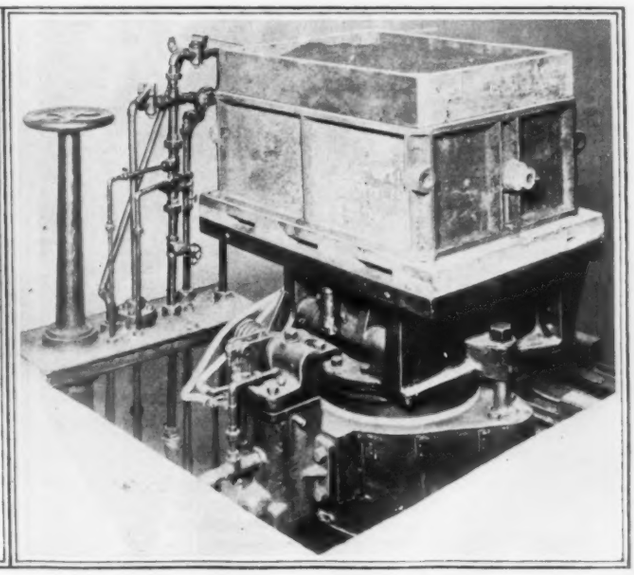


FIG. 2—SAND FRAME AND FLASK IN POSITION ON THE PATTERN PLATE AND FILLED WITH SAND

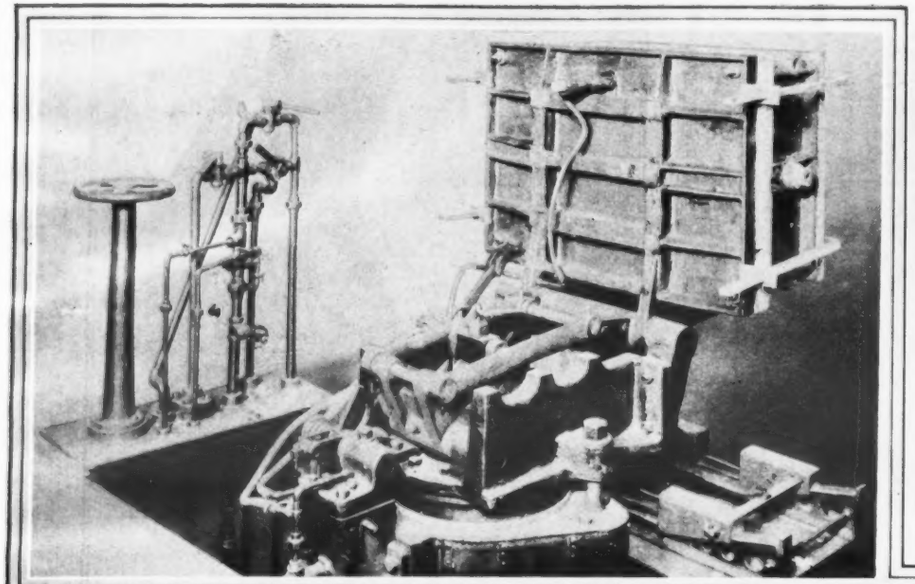


FIG. 3—A VIEW OF THE MOLD WHILE IT IS BEING ROLLED OVER

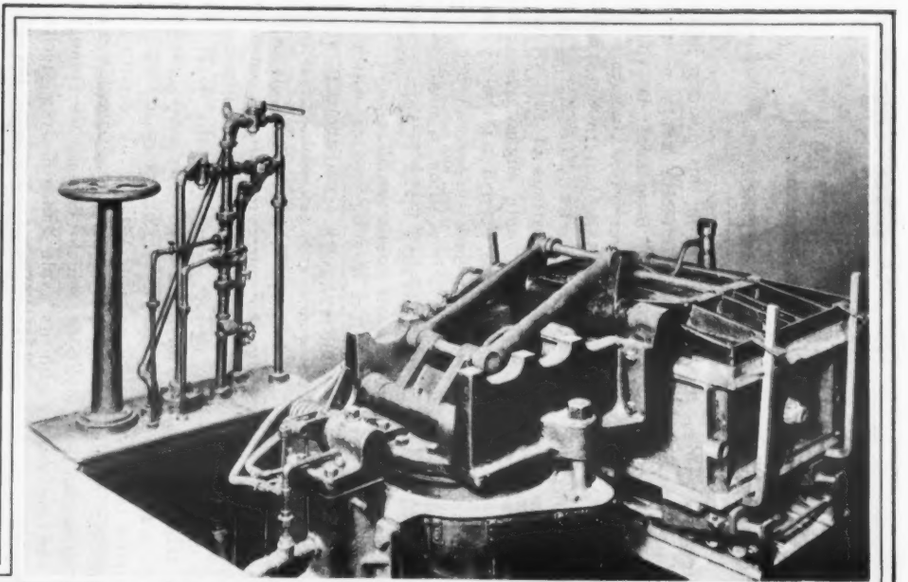


FIG. 4—THE FLASK IN PLACE AND BEDDED READY FOR THE CLAMPS TO BE REMOVED AND THE PATTERN DRAWN

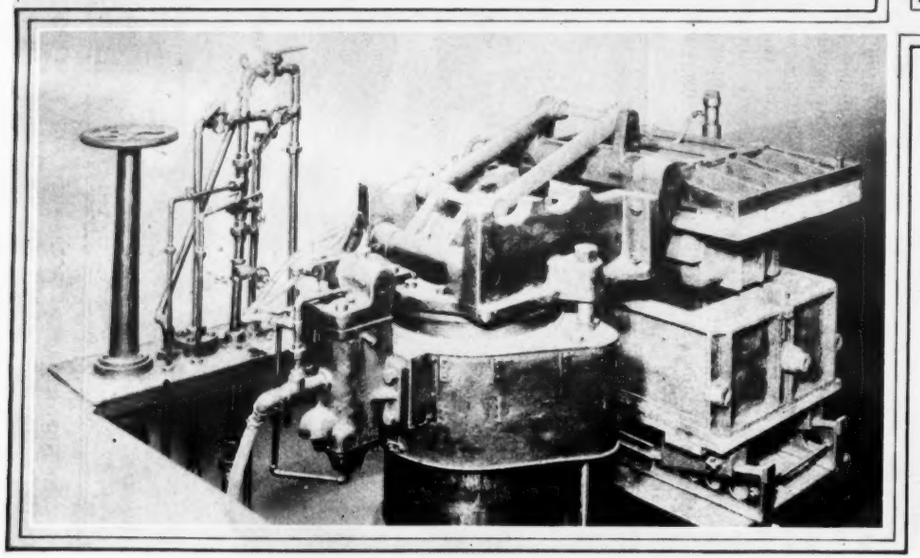


FIG. 5—THE PATTERN DRAWN VERTICALLY FROM THE MOLD

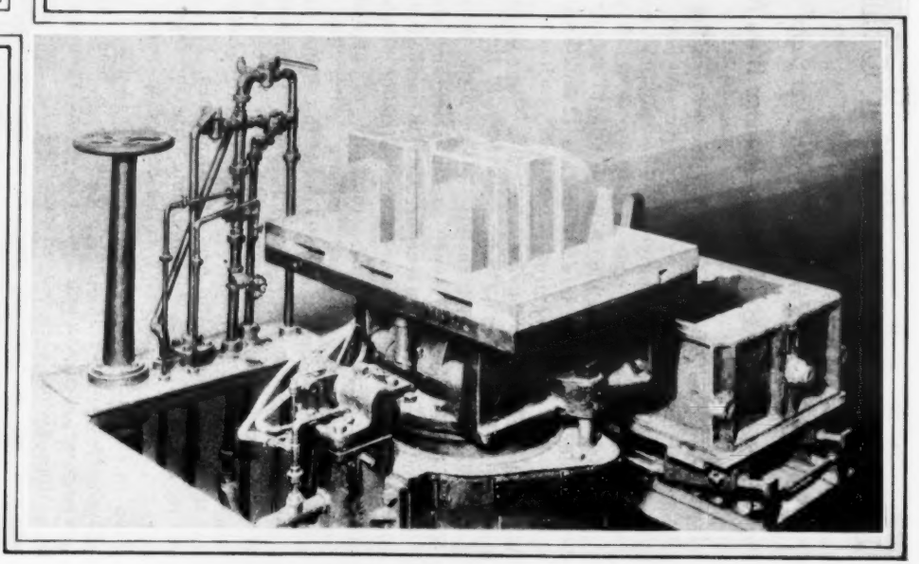


FIG. 6—PATTERN RETURNED TO ITS ORIGINAL POSITION READY FOR MAKING THE NEXT MOLD

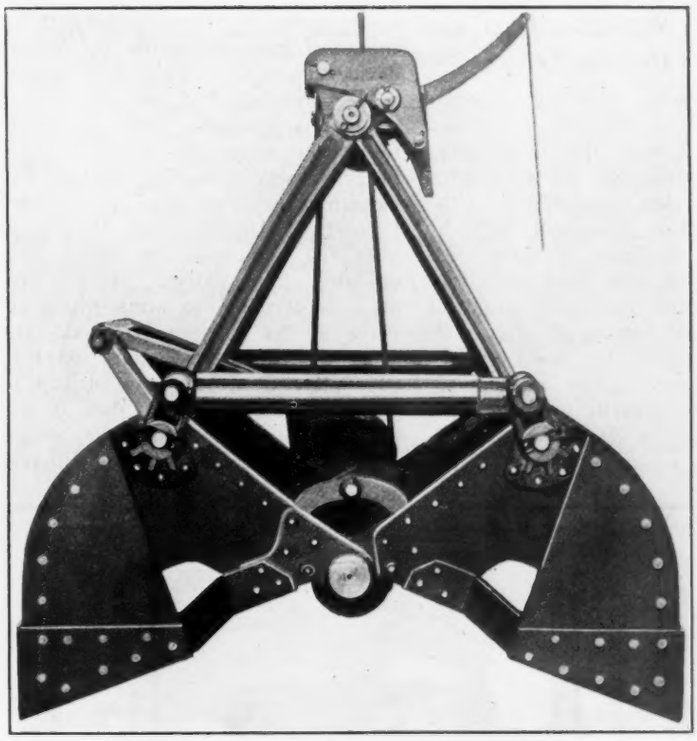


FIG. 1—PAWLING & HARNISCHFEGER IMPROVED FOUNDRY GRAB BUCKET OPEN

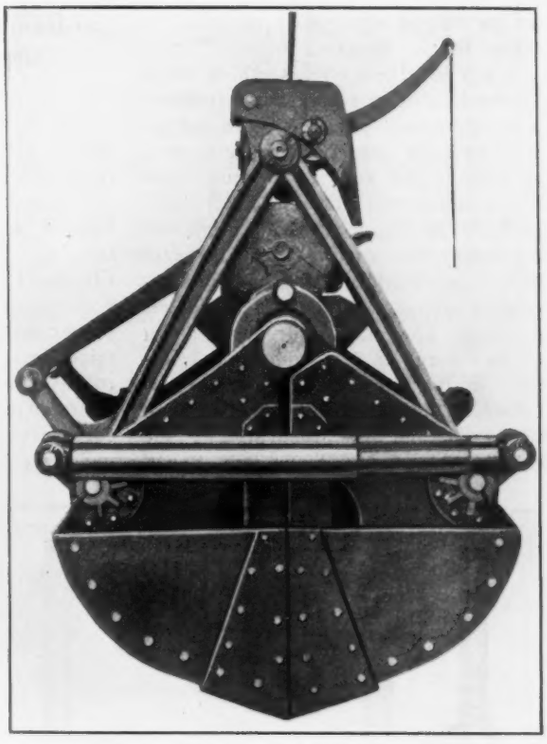


FIG. 2—IMPROVED FOUNDRY GRAB BUCKET CLOSED

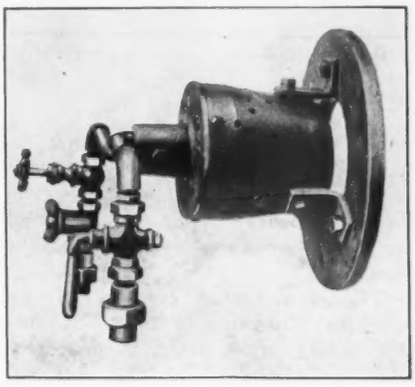
ently arranged on the operating stand. Several larger machines of the same type are now under construction at the plant of the Tabor Mfg. Co.

Hauck Furnace Burner

A furnace burner, operated with compressed air or steam and any grade of fuel oil, manufactured by the Hauck Mfg. Co., Brooklyn, N. Y., is shown in the accompanying illustration. The combustion chamber is located in the nozzle of the burner, which is cone-shaped and of dimensions varying with the size of the burner. The burner is mounted on a flange which can be attached to the heating chamber or furnace. The pipe line connections for compressed air and oil, with suitable regulating valves, are shown in the accompanying illustration and a special oil needle valve strainer, close to the oil valve, prevents sediment in the oil from entering the burner. The burners can be operated by high or low pressure air or steam and are also built for operation by fan blast or positive pressure. The self-contained type of furnace burner can be operated by a hand pump mounted inside of the oil tank. With this style of burner kerosene oil only can be used, while any grade of fuel or crude oil can be employed with compressed air or steam burners. These burners, which are adapted to heating core and drying ovens, melting furnaces, annealing, heating and tempering furnaces, etc., are manufactured by the Hauck Mfg. Co., Brooklyn, N. Y.

Improved Foundry Grab Bucket

The Pawling & Harnishfeger Co., Milwaukee, has recently made some radical changes in the design of its foundry grab bucket. The bucket is of the single-line type and when in use is simply suspended from the hook of the traveling crane. The new bucket operates on the same principle as the former types, although the details of its mechanism have been considerably altered. One of



HAUCK FUEL OIL FURNACE BURNER

the chief improvements effected has been the substitution of pneumatic recoil cylinders in place of the chain which was first used to arrest the shock of opening.

The improved bucket is shown open and closed in Figs. 1 and 2. The shape of the bucket has been changed so that there are no corners or pockets in which sand can lodge. Since the bucket opens through the action of gravity, there is an appreciable shock when it reaches its fullest extension. This is absorbed by two horizontal dash pots or air cylinders which are fastened to the leaves of the bucket. These cylinders are so situated that they are protected from accidental injury. The bail which fits over the crane hook is provided with springs which effectively absorb any shock arising when the load is applied.

A bucket of this type, it is said, is being used successfully in a Milwaukee steel foundry to remove finished castings from the sand and considerable economies are understood to have resulted from this method of cleaning up the floors.

In a typical heat at this foundry 8 tons of metal were poured in about 50 separate molds. The pouring commenced about 9:45 p. m., and ended about 11 p. m. After the castings were poured and were partially cooled they were shaken-out in a heap in front of the furnaces, a traveling crane and two men being employed for this work. The flasks were picked up with the crane and the sand knocked out by the two men with sledges.

After all the molds had been shaken out and the flasks removed, a chain was attached to the crane hook and the castings were snaked out of the sand, roughly shaken-off and piled

up on a large steel plate ready to be taken to the chipping room.

When all the castings which could be reached in this way were removed from the sand pile, the grab bucket was brought into service and used to remove the sand to various floors and molding machines, where it could be used again, at the same time recovering the castings which were buried in the heap. During this operation about 20 castings were recovered. The sand pile was about 60 feet long, 12 feet wide and 3 feet deep in the center. The entire operation, including the redistribution of the sand and the recovery of the castings, required about two hours' time. Only two laborers were employed, together with the craneman, instead of a gang of six men working nearly half the night, which had been necessary when this work was done by hand.

W. Gibbons Uffendell, for the past four years architect for the International Harvester Co., Chicago, and Nicholas H. Holmes, formerly designing engineer in the department of bridges and buildings of the Southern Pacific railroad, have formed a partnership under the firm name of Uffendell & Holmes, for the general practice of architecture, specializing in the design of factories, warehouses, power plants, foundries, machine shops, etc. Offices have been established at 1328 McCormick building, Chicago.

Jar-Rammer With Roll-Over and Pattern-Drawing Device

A jar-ramming molding machine equipped with a roll-over device and which also lowers the mold away from the pattern, or the core from the core box, has been added to the line of molding equipment built by the U. S. Molding Machine Co., Cleveland. The only hand operations performed when making a mold or core consist of butting-off after ramming and rotating the mold on the roll-over supports. The machine illustrated has a capacity for molds and core boxes up to 20 inches and 12-inch draft. Larger sizes also are built, and the same principles of construction and operation, with only a few slight modifications, are embodied in machines for making molds or cores weighing several thousand pounds.

The jar-ramming cylinder of the machine illustrated in Fig. 1 is only 3½ inches in diameter. Compressed air is admitted to the cylinder through the small hose shown in the foreground and is exhausted through the large hose, passing through an exhaust valve to the atmosphere. A ⅜-inch air inlet valve and a 1-inch exhaust valve are employed. The cylinder is attached to the foundation plate or anvil with studs and only a light timber foundation is required. The base plate is extended at the ends and forms a support for the steel rods on which the rolling device operates. Two steel-bushed guides are attached to the bottom of the jar-ramming table to steady the latter when the mold is being lowered away from the pattern. The pattern or roll-over plate is suspended from two sleeves which loosely fit over the side rods on which they operate. The pattern or roll-over plate is attached to arms which revolve in the roll-over sleeves. The arms to which the pattern or roll-over plate is attached are drilled to permit of adjusting the plate in different positions, so that the weight of molds or core boxes of different depths can be equally distributed, thereby facilitating the roll-over operation. Shoes inside of the sleeves engage with the side rods when the hand wheels attached to set screws are turned to lock the sleeves onto the rods. Each corner of the pattern or roll-over plate is slotted for bolts by which the pattern plates are attached and when making cores, the core box is held in position by four angles bolted to the plate through the slots and the core box is attached to these angles by screws.

In Fig. 1 the machine is in position for mounting the pattern plate or core box, preparatory to molding. In this illustration the four steel angles are in position. The core box, Fig. 2, is attached to the roll-

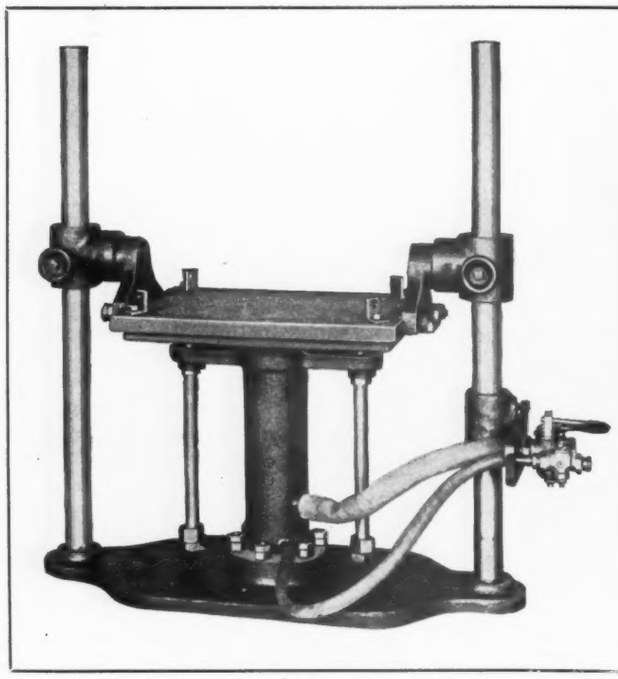


FIG. 1—COMBINATION JAR-RAMMING, ROLL-OVER AND PATTERN-DRAWING MOLDING MACHINE, SHOWING ROLL-OVER PLATE ON WHICH PATTERN OR CORE BOX IS MOUNTED

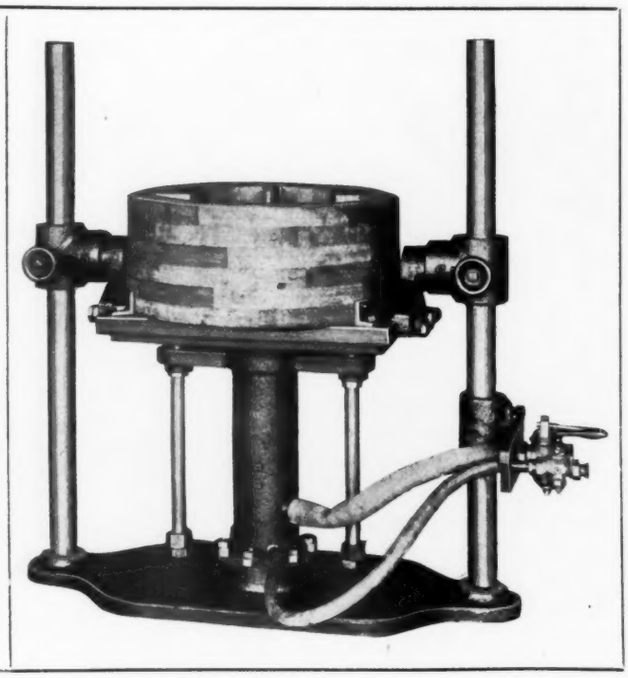


FIG. 2—CORE BOX MOUNTED ON ROLL-OVER PLATE IN POSITION FOR JAR-RAMMING THE CORE

over plate by screws passing through these angles. After the core box is filled with sand, or a flask if a mold is to be made, air is admitted to the cylinder and the core is jar-rammed. After slightly butting-off the core plate is rubbed-on and clamped. The exhaust valve is then closed and when air is admitted to the cylinder, the core box and roll-over device are elevated by the piston to the position shown in Figs. 3 and 4. The sleeves are then locked onto the side rods by turning the two hand wheels and the core is supported in the elevated position while the piston is lowered by opening the exhaust valve. The core is sleeves on the side rods are momentarily loosened by turning the two hand wheels and the core box or flask comes to rest on the receiving table of the jar-ramming machine and thereby is leveled automatically. The sleeves are locked again to the side rods to support the pattern or core box while the mold or core is being lowered. The clamps are then removed, the vibrator is actuated and the mold or core is lowered on the jar-ramming table when the air is exhausted from the cylinder. The core drawn from the core box is illustrated in Fig. 4. After the core is removed, the core box is rolled over, the exhaust valve is closed and

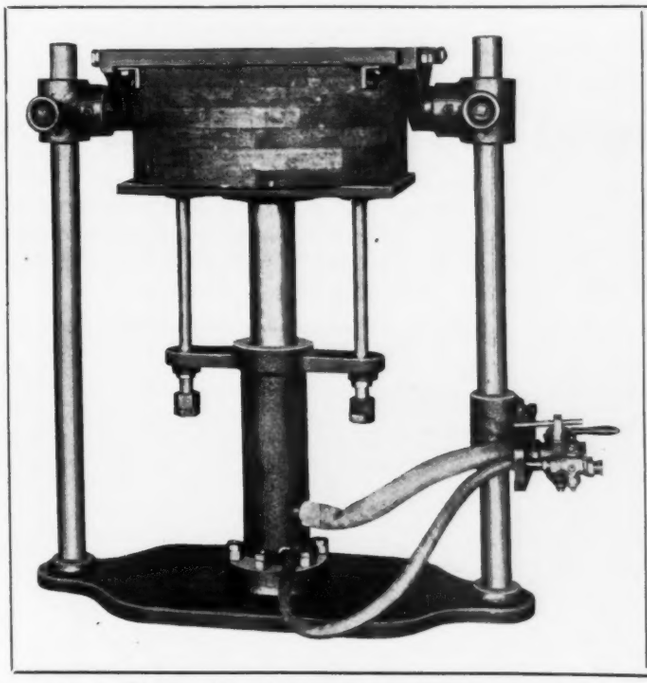


FIG. 3—CORE BOX ROLLED OVER BEFORE LOWERING THE CORE FROM THE CORE BOX

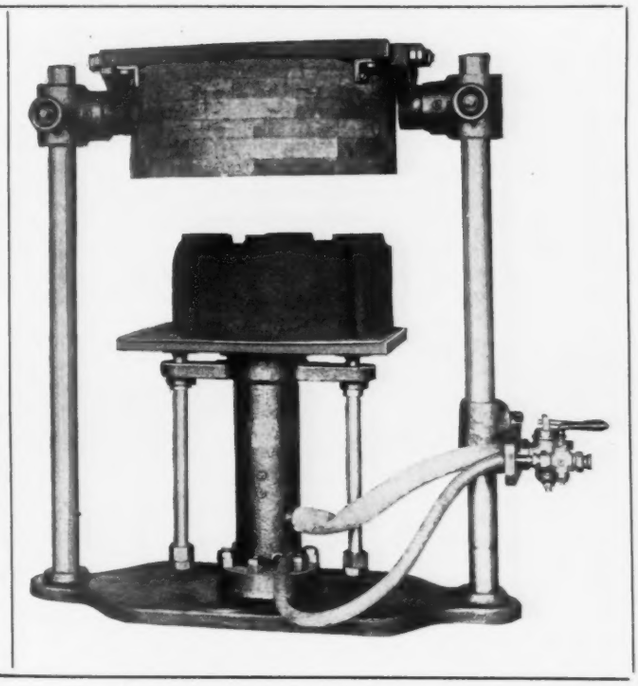


FIG. 4—THE FINISHED CORE READY TO BE CARRIED AWAY TO THE CORE OVEN

next rolled-over by hand and assumes the position shown in Fig. 3. After again closing the exhaust valve and admitting air to the cylinder, the piston and jar-ramming table are elevated, preparatory to lowering the core away from the core box. To insure an absolutely perfect draw, the mold must be leveled on the jarring machine table and this is accomplished by an exceedingly simple and ingenious device wich compensates for any irregularities in the bottom-board or core plate.

Up to this point in the mold or core-making operation, the core or mold is supported by the roll-over device, although the jar-ramming table has been raised and is in contact with the core plate or bottom-board. To level the flask or core box, the the piston is raised by admitting air to the cylinder. After unlocking the side sleeves, the piston is lowered and the core box again assumes its initial position for making another core.

The Damascus Bronze Co., Pittsburgh, in a handsomely-illustrated catalog, shows numerous interior views of its shop which is well-equipped for the production of nickel bronze and phosphor bronze bearing metals. This company also furnishes in ingot form, hydraulic bronze which has a tensile strength of 36,000 to 38,000 pounds per square inch, which has been subjected to hydraulic pressure of 7,000 pounds per square inch. Steam metal, phosphorized copper and other alloys are described.

Death of N. W. Shed

Prof. N. W. Shed, widely known as a foundry metallurgist and a frequent contributor to the columns of THE FOUNDRY, died at his home in Buffalo, May 3. Nearly four months ago, Prof. Shed underwent an operation for appendicitis which subsequently developed complications that resulted in his death. He held the chair of metallurgy in the University of Buffalo and was chemist for the Buffalo Foundry & Machine Co. Prof. Shed was born in Roxbury, Mass., Dec. 2, 1859, and graduated from the Massachusetts Institute of Technology in 1881, where he served as an instructor for one year. From 1883 to 1888 he was superintendent of the Nashua Iron & Steel Co., Nashua, N. H., and from 1888 to 1892 he was employed as a metallurgist with the Carnegie Steel Co., Phoenix Iron Co. and the Pittsburgh Reduction Co. In 1898, Prof. Shed was appointed assistant professor of mining and metallurgy in the Pennsylvania State College, where he remained until 1901. In 1902, he established an office in Buffalo as a consulting chemist and metallurgist and during the past three years held the chair of metallurgy of the University of Buffalo. Throughout this period he was identified also with the Buffalo Foundry & Machine Co. He is survived by two sons, both residents of Buffalo.

Molding Sand Shipments

Shippers of molding sand throughout the east and central west are experiencing great difficulty in obtaining cars and the supply since last November, when the car shortage at the sand pits was acute, has not been increased. A car shortage during the spring months is unusual and it is the first time in many years that miners of sand have been unable to obtain a sufficient number of cars to ship their product at this season of the year. The Pennsylvania railroad also has placed an embargo on all cars of less than 50,000 pounds capacity and will not accept them for transportation over its lines.

If the usual car shortage which exists during the months of September and October is to be measured by the present shortage of supply, it is evident that little equipment will be available for the various sand pits throughout the country in the fall months, owing to the fact that the grain movement is of prime importance and all available cars are sent to the west and northwest when this commodity is to be shipped. For this reason sand shippers are unanimously of the opinion that foundrymen should place orders now for the early delivery of their winter sand supply, as it can be delivered to advantage during the summer months.

Trade Publications

AIR COMPRESSORS.—In a 24-page catalog, the extensive line of air compressors built by the American Compressor & Pump Co., Baltimore, is illustrated and described. Both electric and steam-driven compressors are shown in various sizes for different classes of work. This company also manufactures air receivers, air lift pumping systems, high duty dry vacuum pumps, compressed air tools and appliances. A number of useful tables conclude the catalog.

PAXSON-COLLIAU CUPOLA. — In bulletin No. 26, issued by the J. W. Paxson Co., Philadelphia, the Paxson-Colliau cupola is illustrated and described. Blowers for operating this furnace are shown as well as sectional views which illustrate its construction in detail. Several pages are devoted to suggestions for operating this type of cupola, together with recommendations regarding the methods of charging, melting, etc. The catalog is well-arranged and contains several pages devoted to cupola fire brick, cupola tenders' tools, patent cupola breast and runner, charging floor elevators, cars, scales for weighing charges, etc.

STEAM PUMPS.—The Ingersoll-Rand Co., 11 Broadway, New York City, in a recently-issued bulletin, illustrates and describes Cameron steam pumps. The steam mechanism consists only of four pieces, none of which is delicate, intricate or exposed to injury. The operation of this mechanism is such that while under full pressure of steam the suction pipe may be lifted out of the water and the pump may be allowed to race as fast as steam will drive it without danger of the piston striking the head or injuring the pump. The advantage of this is evident since any pump is liable to have its supply of water cut off unexpectedly. The steam valve movement works in line with the piston rod without the intervention of arms or levers. The pump cannot reverse until it has completed its full stroke and it can be taken apart completely without disconnecting any of the pipes. The bulletin shows the different styles of pumps manufactured and contains tables of sizes and capacities together with prices.

MOLDING MACHINES. — The complete line of molding machines, sand sifters and other foundry equipment, manufactured by the Arcade Mfg. Co., Freeport, Ill., is illustrated and described in a handsome two-color, 54-page catalog issued by this company. The various labor-saving molding machines not alone are shown, but in addition, views of foundry floors are included which graphically illustrate the capacities of these machines. Castings varying in weight from ounces to thousands of pounds made on the Arcade line of machines, also are illustrated. The types of molding machines shown include the Modern, which is used to produce molds usually made in snap flasks by bench molders. Several views of sash weight equipment for making such molds on the Modern machine are included, as well as patterns for stove lids, long center castings, etc. The description of the pattern plate equipment, as well as details of making white metal pattern plates, composition plates, etc., are unusually complete. The automatic molding machine built by the company also is shown. An extensive line of squeezers is manufactured on which gated metal patterns, as well as pattern plates may be used. The heavy duty Arcade squeezers illustrated are built for handling flasks up to 36 inches in length. This type of squeezer is built in two sizes containing one and two cylinders. A combination jolter and squeezer which may be used as a simple squeezer, a plain jolting machine or for the combination jolting and squeezing operations, is included. A large section of the catalog is devoted to Norcross jolting machines. Single, two and three-cylinder machines are shown, as well as a small core jolting machine. The rotary sand sifters, which conclude the catalog, are driven by electric power, air motor or by hand. This catalog is unusually comprehensive and well-arranged and should prove of value to every foundryman.

General Industrial Notes

The American Range & Foundry Co., Cleveland, contemplates the erection of a new foundry.

The Allen Mfg. Co. is now located in the plant formerly occupied by the Henry & Wright Mfg. Co., Hartford, Conn.

The Firestone Steel Foundry Co., Chicago, has been incorporated with a capital of $10,000. The incorporators are R. L. Foote, A. A. Firestone and M. M. Choate.

The Western Malleable Castings Co., Los Angeles, Cal., has been incorporated with a capital of $100,000. The incorporators are W. F. Kerr, C. A. Pott, H. S. Clewitt and J. H. Sims.

The Continental Foundry Corporation, Fort Madison, Ia., has been incorporated with a capital of $250,000 and will operate an iron foundry. The incorporators are Lewis F. Ostrander, Geo. W. Franzheim, John J. Ostrander, Wm. F. Stewart and Cabell Gray, all of St. Louis.

The H. J. Frank Foundry Co., Davenport, Ia., is erecting a new foundry at a cost of $12,500, which will be 80 x 150 feet, part of which will be used as a machine shop. All of the necessary equipment has been purchased and the company expects to pour its first heat about the middle of June or the first of July. This shop will engage in the manufacture of light gray iron castings, sash weights, grate bars, stove and furnace repairs, etc.

New Construction

The Belknap Mfg. Co., Bridgeport, Conn., will erect a foundry, 48 x 131 feet, of brick and steel construction.

The Swedish Crucible Steel Co., Detroit, will erect a new foundry building, 80 x 100 feet, and an office building, 25 x 30 feet.

The International Hoist Co., Antigo, Wis., will erect two new buildings, a foundry, 60 x 90 feet, and a machine shop, 40 x 80 feet.

The Union Steam Pump Co., Battle Creek, Mich., contemplates the erection of a four-story foundry and pattern shop, at an estimated cost of $50,000.

The plant of the Wyandotte Foundry Co., Wyandotte, Mich., recently destroyed by fire, will be rebuilt. The new plant will be 100 x 140 feet, of steel and concrete construction.

The Welland Machine & Foundries Ltd., Welland, Ont., is having plans prepared for a new foundry which will be equipped with an overhead, electric traveling crane.

The Aluminum Castings Co., Cleveland, contemplates the erection of a new foundry at Milwaukee, to which it will remove its plant now located at Manitowoc, Wis.

The West Steel Casting Co., Cleveland, will enlarge its plant by the erection of a new foundry, 52 x 70 feet. A 10-ton crane and an additional converter will be installed.

The Modern Foundry Co., Cincinnati, O., contemplates the erection of a one-story addition to its foundry, 36 x 190 feet. The new building will be of brick and steel construction with a saw-tooth roof.

Among the Brass Founders

The Wolverine Brass Co., Grand Rapids, Mich., has commenced work on the erection of a large addition to its plant. The new buildings will be constructed of steel and concrete. A new foundry is among the improvements contemplated.

The Clark Novelty Co., Rochester, N. Y., manufacturer of brass castings and metal hardware novelties, has acquired the plant of the American Drafting Furniture Co. of that city and will make extensive improvements, including the erection of a new brass foundry.

The Hains, Jones & Cadbury Co., Philadelphia, is enlarging its plant by the addition of a three-story building, 60 x 108 feet, the second and third floors of which will be used as an extension to its pattern shop and brass foundry, and the first floor and basement for the storage of pipe and metals.

Bureau Bros., Philadelphia, manufacturers of artistic bronze castings, are building a new two-story plant at Twenty-third and Westmoreland streets, Philadelphia. The office, studio and drafting room will be on the second floor and the foundry, finishing shop and machine department on the first floor. The plant will be 100 x 164 feet.